Model Flying HANDBOOK

By Ottar Stensbol

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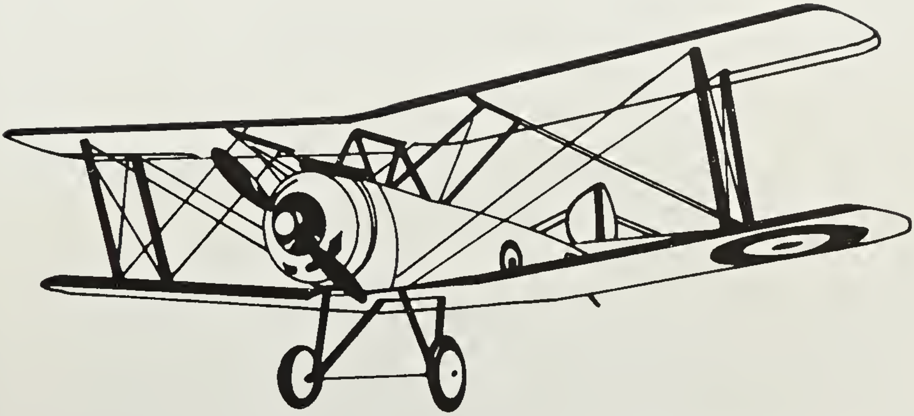

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Contents

Types of Model Airplanes

A newcomer to the model flying hobby may be puzzled by the large number of different airplane types in use. Until about 30 years ago this was no problem at all, since at that time only rubber-powered, free-flying models of simple construction were available. These are still used today but mainly by younger enthusiasts for their first efforts.

Among the many types of model aircraft are some with motors—engine-powered—and others without—sailplanes or gliders. Whether powered or not, models may be free-flying or telecontrolled (*tele-* = operating at a distance). The tele-controlled airplanes are either line-controlled or radio-controlled.

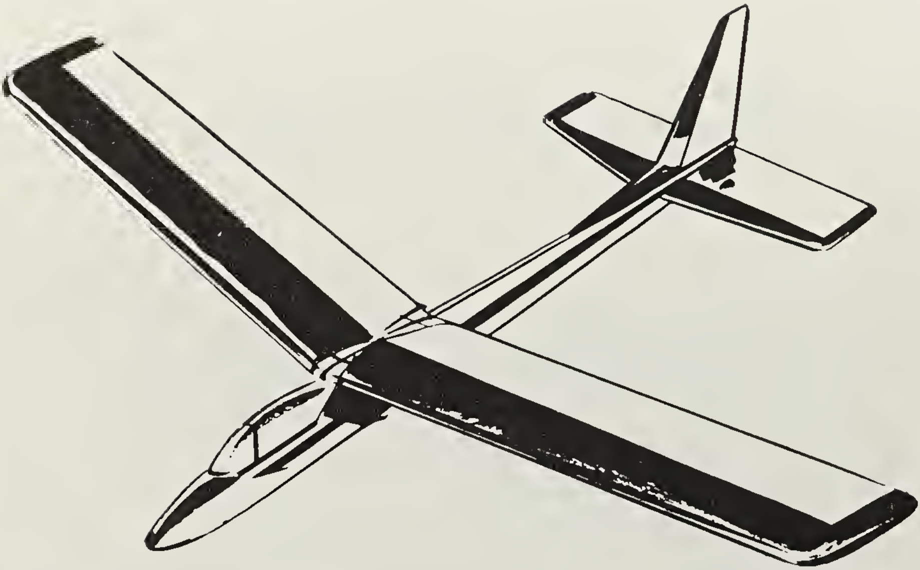
Model airplanes may be either in exact scale to their full-size originals or so-called functional models which do not follow their prototypes as faithfully, but are designed with an eye more to the stability and flying performance of the model itself. A beginner is likely to be more successful flying a functional model.

Model airplanes fall into four basic categories—free-flying, line-controlled, radio-controlled and non-flying.

Free-Flying Models

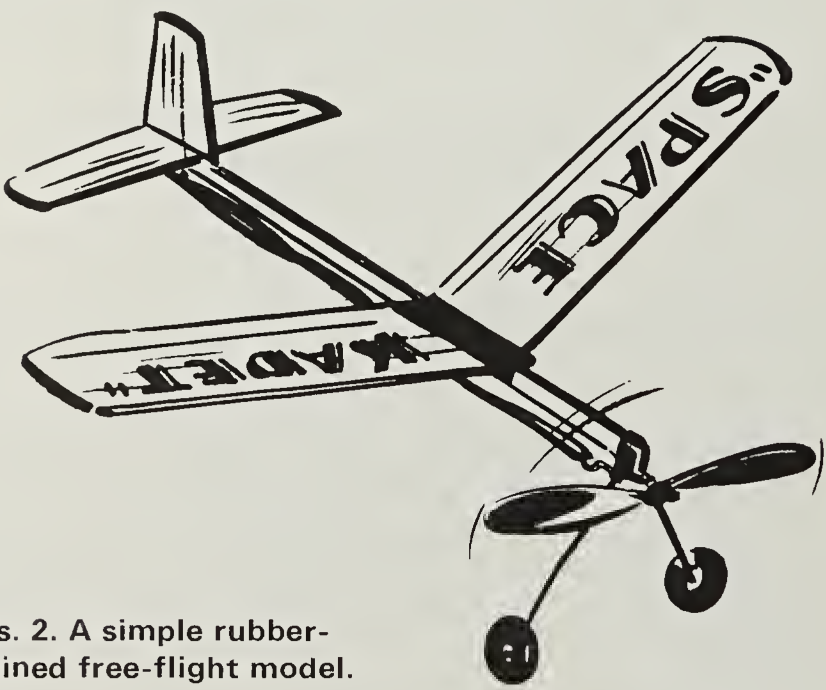
GLIDERS

Gliders are small, simple model airplanes without any power installation. Ideal for beginners, a glider is easy to build, will take a lot of punishment and will demonstrate to its pilot some of the principles of aerodynamics, a field he needs to understand to fly the more advanced, powered models successfully.



Illus. 1. A simple free-flying glider.

Larger gliders of more sophisticated design are used for competition flying. They are more vulnerable than simple gliders and must be handled with care, but their flying performances are generally very good.

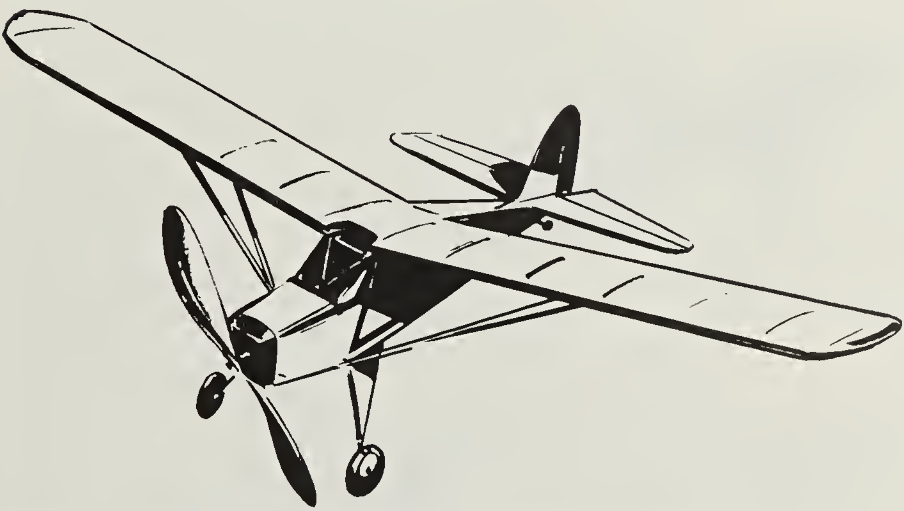


Illus. 2. A simple rubber-engined free-flight model.

RUBBER-POWERED MODELS

These craft have a rubber "motor" which turns the propeller. This motor consists of one or more rubber bands fastened between the propeller shaft and the rear of the fuselage. Of course, these rubber-powered models can be simple or built to resemble an actual aircraft.

A basic glider serves very well as an effective trainer. Building a powered model is a far more complicated project than producing a glider of similar size and design.



Illus. 3. A more sophisticated free-flying plane.

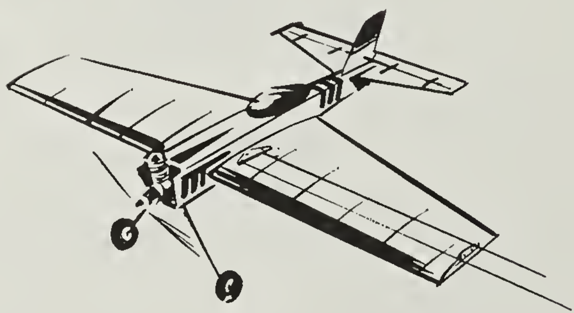
COMBUSTION-ENGINE-POWERED MODELS

This type of craft is usually referred to as just "powered models." Whether exact scale or functional models, all are powered by an internal-combustion engine. These are small diesel or ignition engines which produce remarkable power for their size.

These engines can be fitted into simple models or into the more sophisticated, cabin-type sports models. While they are more pleasant to look at, cabin models are difficult to repair in case of a crash. For real competition buffs there are advanced models of many types, the commonest of which is the duration model.

JET- OR ROCKET-POWERED MODELS

The new JETEX motors have made it possible to build realistic scale models of modern jet fighters. The JETEX motor is a small rocket engine which burns a solid fuel pellet. The power is rather low so the model size is, therefore, generally restricted to 30 inches (75 cm.) or less in wingspan. These engines run from 20 to 35 seconds after ignition. Using a lightweight, streamlined model, it is possible to gain enough height for an endurance glide back to earth.



Illus. 4. Two line-controlled or "U-control" model planes.

Line-Controlled Model Airplanes

These are models controlled by lines running between the pilot's hand and a steering mechanism in the model. This system is known as "U-control" because the lines form a "U" shape between the pilot and his craft. U-control models are very popular and can be divided into several groups—trainers, stunt models, combat models, speed models, team racers, and scale models.

All of these are flown around in a circle, tethered to the pilot's hand by the U-control lines. With these simple controls the

pilot can guide his model up and down, do loops and even fly his plane upside down. Compared with the free-flight types of model airplanes, the U-control models offer one distinct advantage—they can be flown in very restricted areas. Even a back yard or tennis court will do. However, one problem that you as a U-control pilot must be aware of, in consideration of your neighbors, is the loud noise of the engine.

Radio-Controlled Model Airplanes

By far the most popular types of models today are those whose flight is controlled by radio signals. These models perform manoeuvres similar to modern full-size aircraft. While this is appealing to newcomers to the hobby, they must realize that some aerodynamic and technical know-how is essential. The best advice for a novice is to build, trim and fly a few good old-fashioned free-flight models first.

Illus. 5. A radio-controlled sailplane (top) and a radio-controlled powered model (bottom).

Both sailplanes and powered models can be radio-controlled. A radio-controlled model airplane is commonly referred to as an "RC-plane" and the pilot is called an "RC-pilot." The radio-control unit is referred to as "RC-gear." With his transmitter, the RC-pilot can control his model just as if he were sitting in the cockpit. His skill plus, of course, the number of servos on his gear and the capability of the control surfaces on his model are the only factors limiting his manoeuvres through the sky.

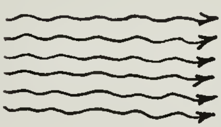
"Non-Flying" Model Airplanes

These are model aircraft meant to be looked at rather than flown. They can be of solid wood, plastic or a combination of materials. Usually constructed to exact scale ranging from 1:72 to 1:24, these display models are frequently built from kits. Painted and with decals added, these models look very realistic. They make an attractive collection and find a natural hangar in youngsters' rooms all over the world.

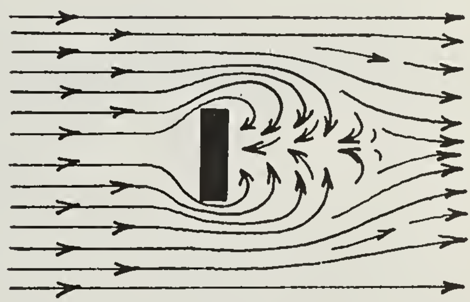
Elementary Aerodynamics

Aerodynamics is often a frightening word to beginning model airplane enthusiasts. The simple, self-explanatory drawings that follow, however, will give you an easy-to-follow introduction to aerodynamics as it applies to flying model aircraft.

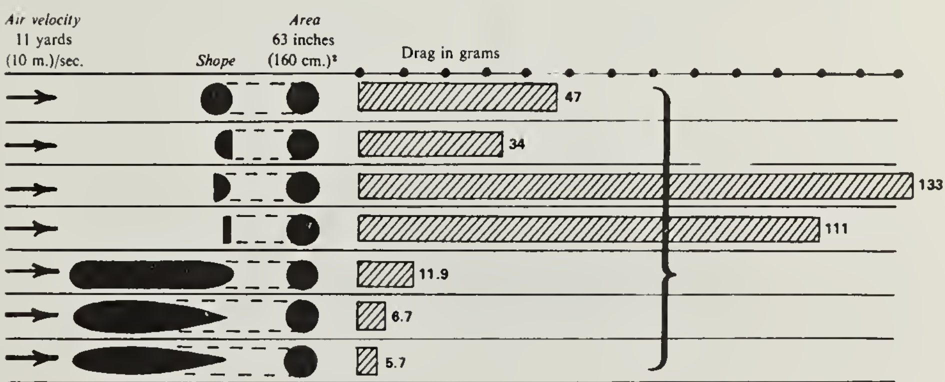
Laminar air stream



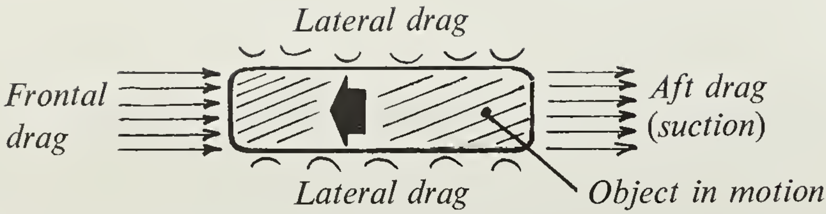
Turbulent air stream



A typical pattern of an air stream striking an object

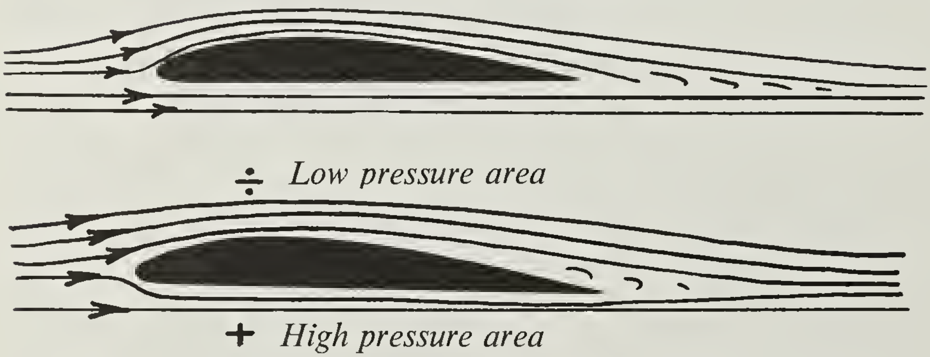


The amount of drag (wind resistance) varies according to the shape of the object.

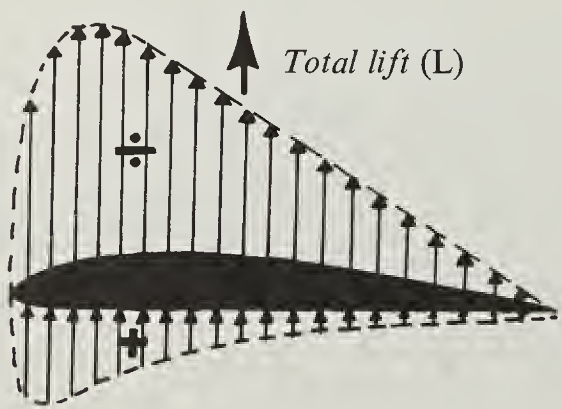


The total drag is the sum of all the drags.

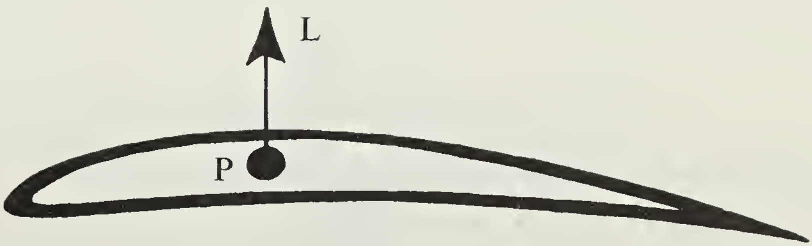
Typical air-flow pattern over a wing.



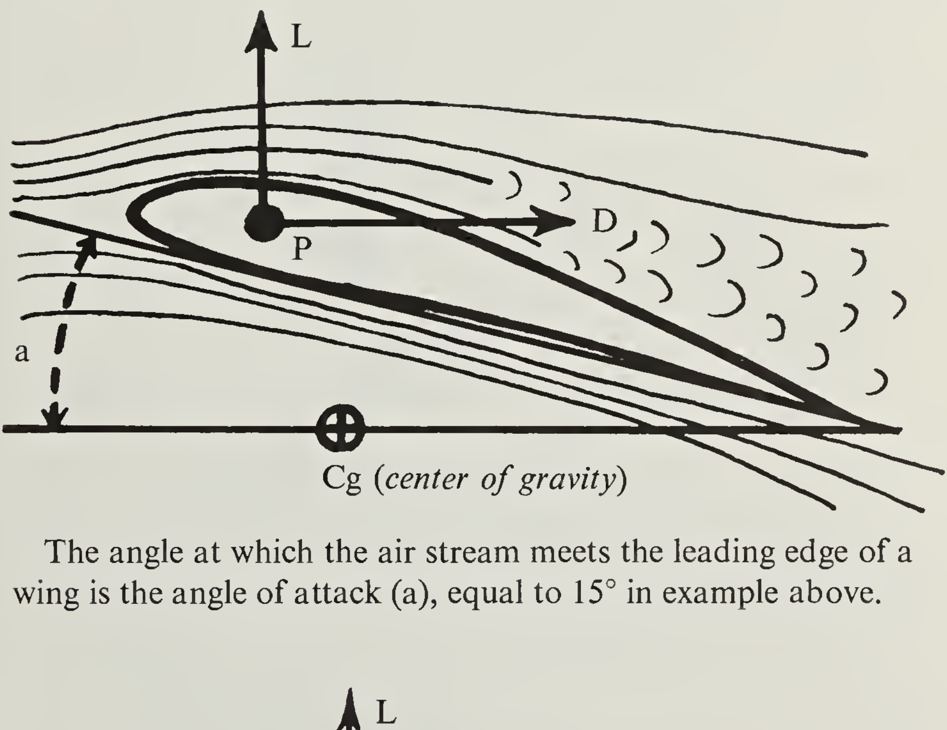
The air flowing over the top of a wing has a greater distance to travel and, therefore, travels faster than the air flowing beneath the wing. This creates an area of lower air pressure above the wing. The greater pressure below lifts the wing towards the area of reduced pressure above.



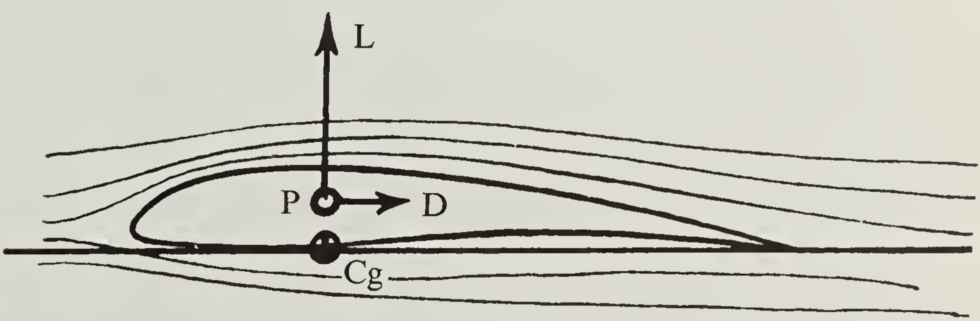
The amount of air pressure varies at different points above and below a wing, resulting in lift.



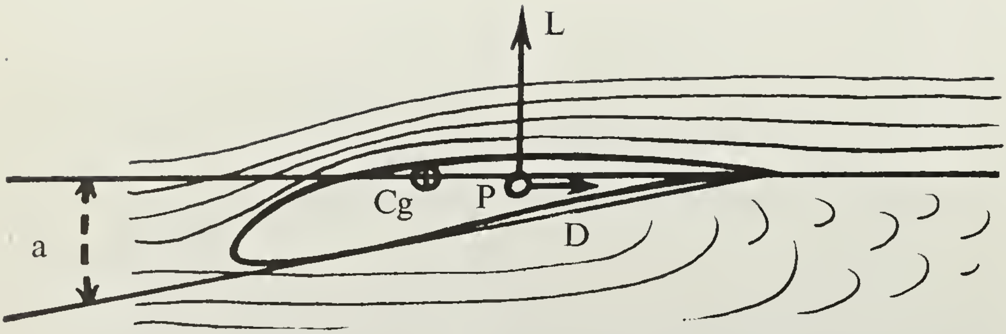
The effect on the wing is as if the total lift (L) was applied to a common center of pressure (P).



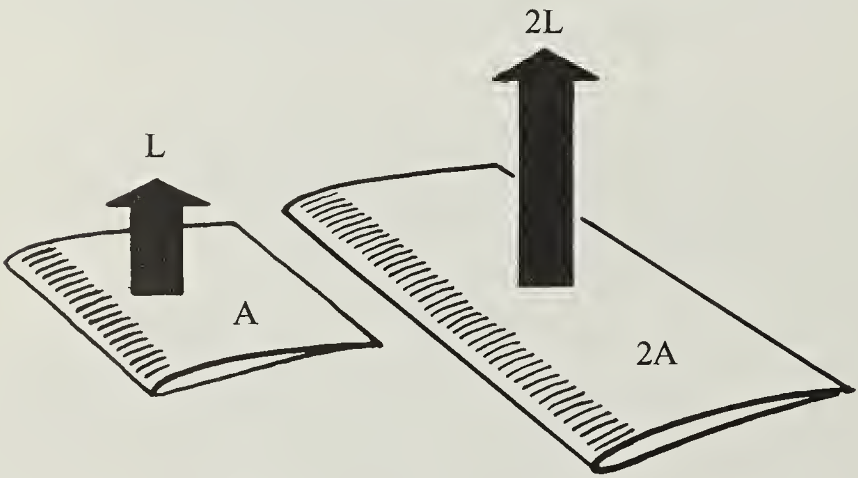
The angle at which the air stream meets the leading edge of a wing is the angle of attack (a), equal to 15° in example above.



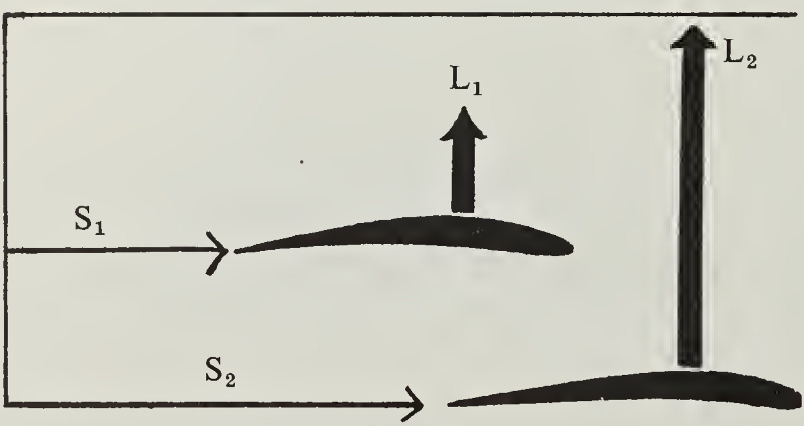
When the air stream meets the leading edge of a wing head-on, the angle of attack is 0.



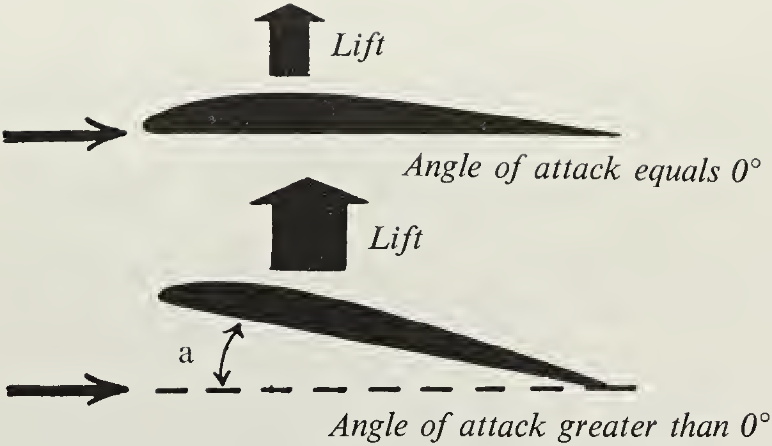
Lift, pressure, and drag vary with the angle of attack.

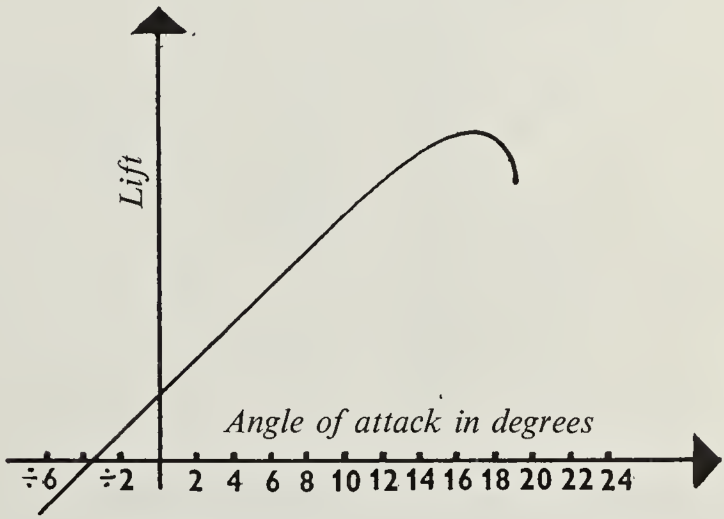


The amount of lift (L) is in proportion to the surface area (A) of the wing.

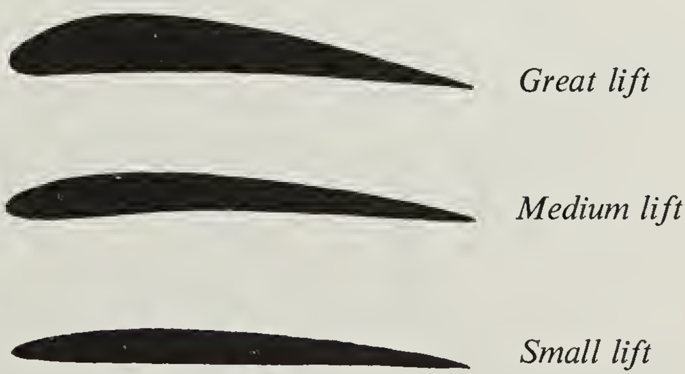


The amount of lift (L) increases with speed (S).

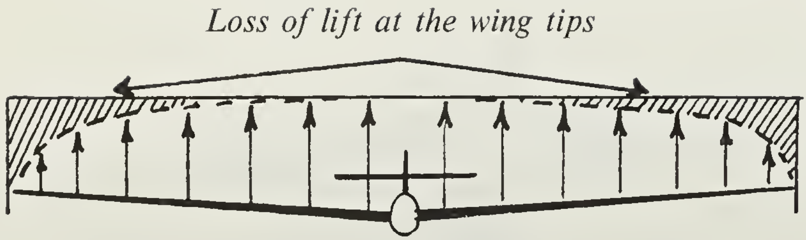




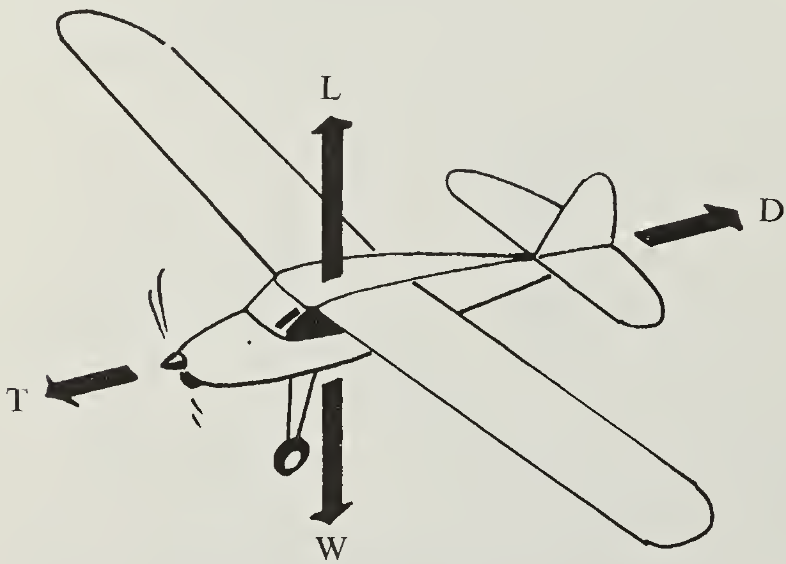
The amount of lift increases with the angle of attack.



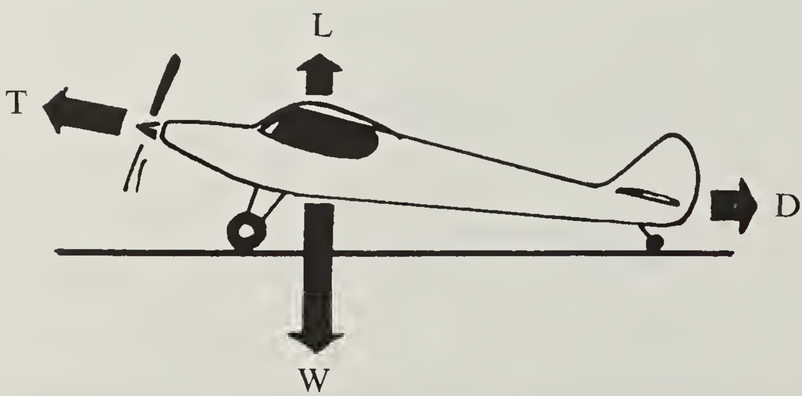
The amount of lift increases with thickness of the wing.



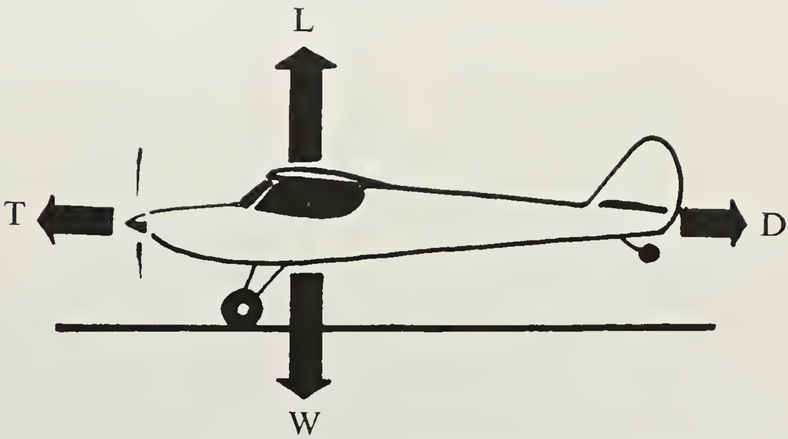
The amount of lift varies at different points along the length of a wing.



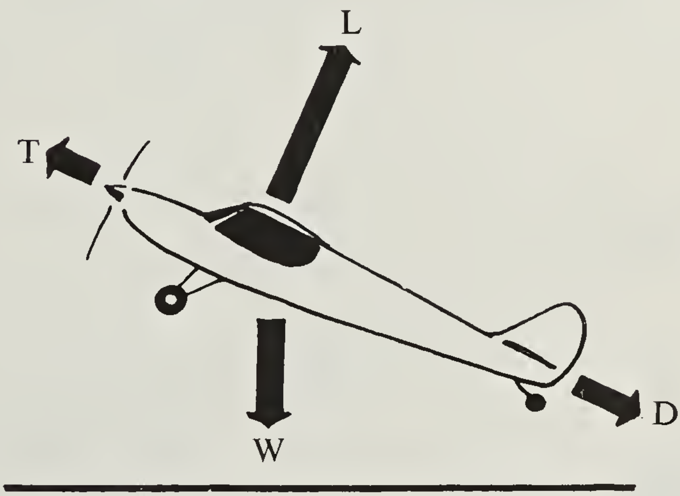
The four forces that act on an aircraft in flight are lift (L), drag (D), weight (W), and thrust (T).



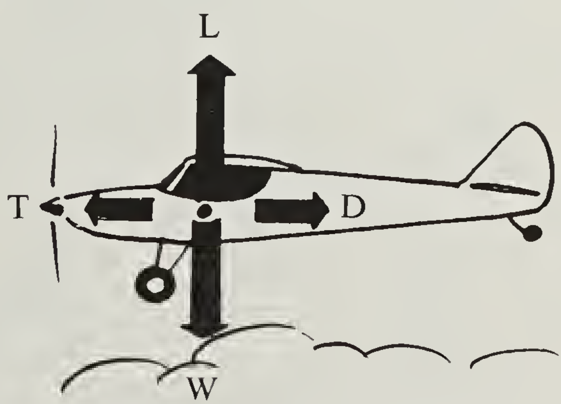
Drag and lift are small for a plane just starting its take-off run because its speed is low.



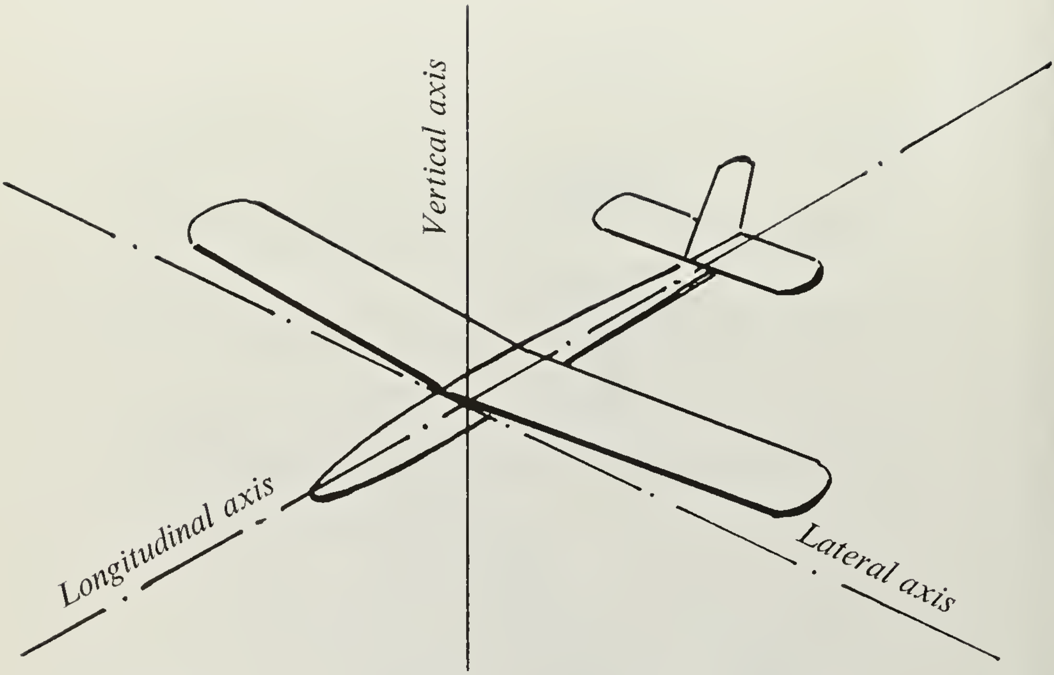
Lift and drag increase as the speed increases before take-off.



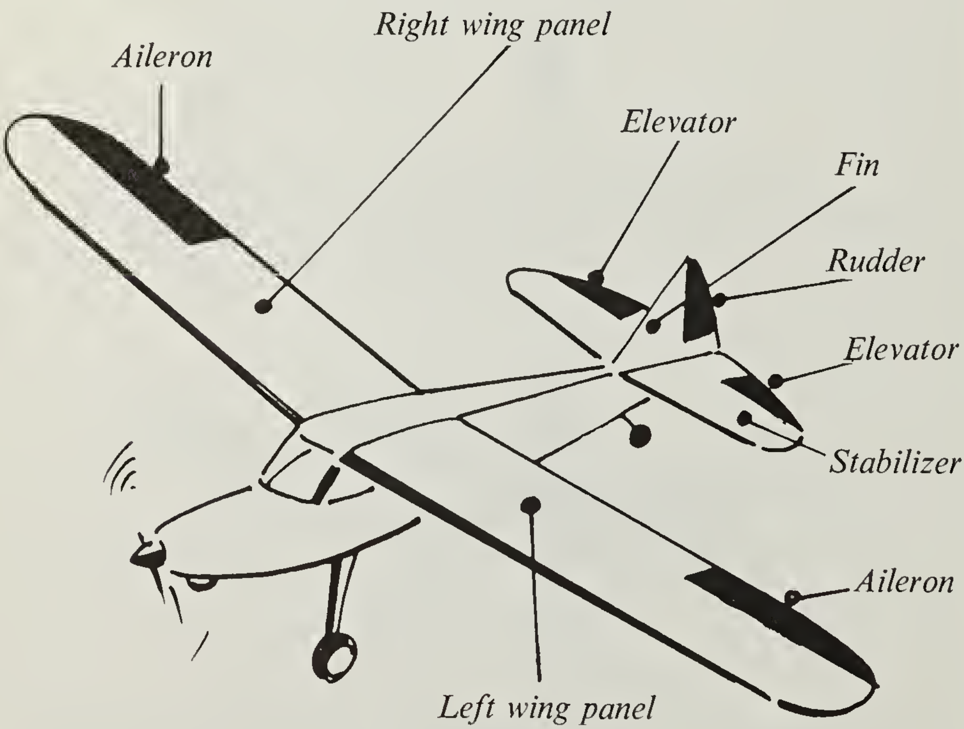
During the take-off and climb, the force of lift is greater than weight.



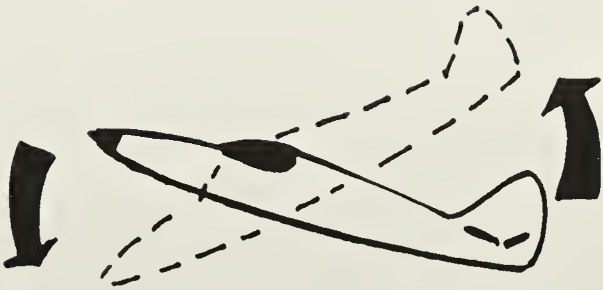
In horizontal flight, lift equals weight while thrust equals drag.



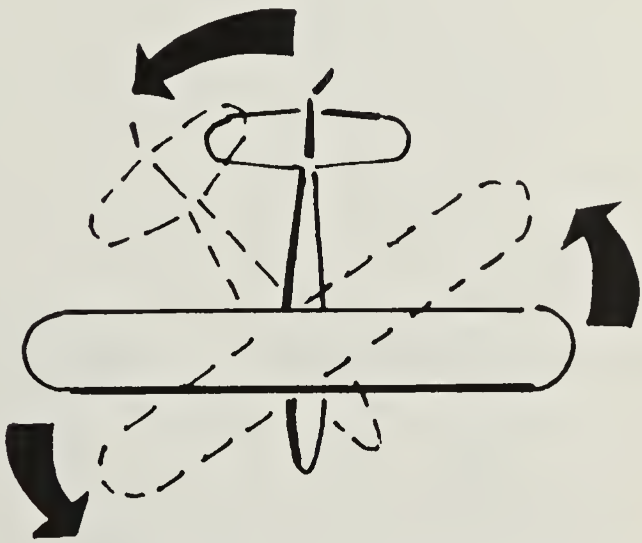
Control surfaces regulate a plane around three axes.



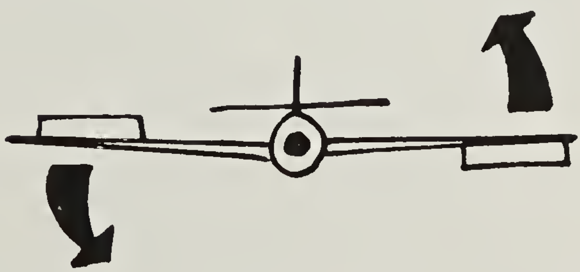
The control surfaces



The elevator moves the plane's tail up and down around the lateral or "pitch" axis.



The rudder causes movement around the vertical or "yaw" axis.



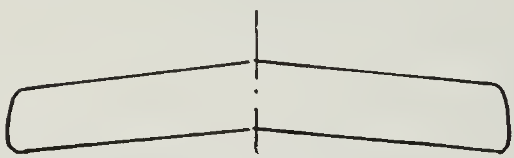
The ailerons move the wings up and down around the longitudinal or "roll" axis.

Constant chord

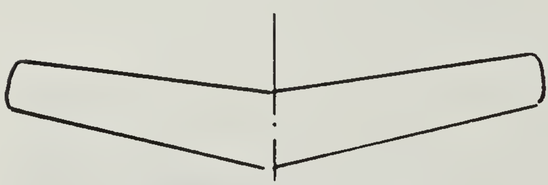
Constant midsection with tapered wing tips

Tapered wings

Elliptical wings

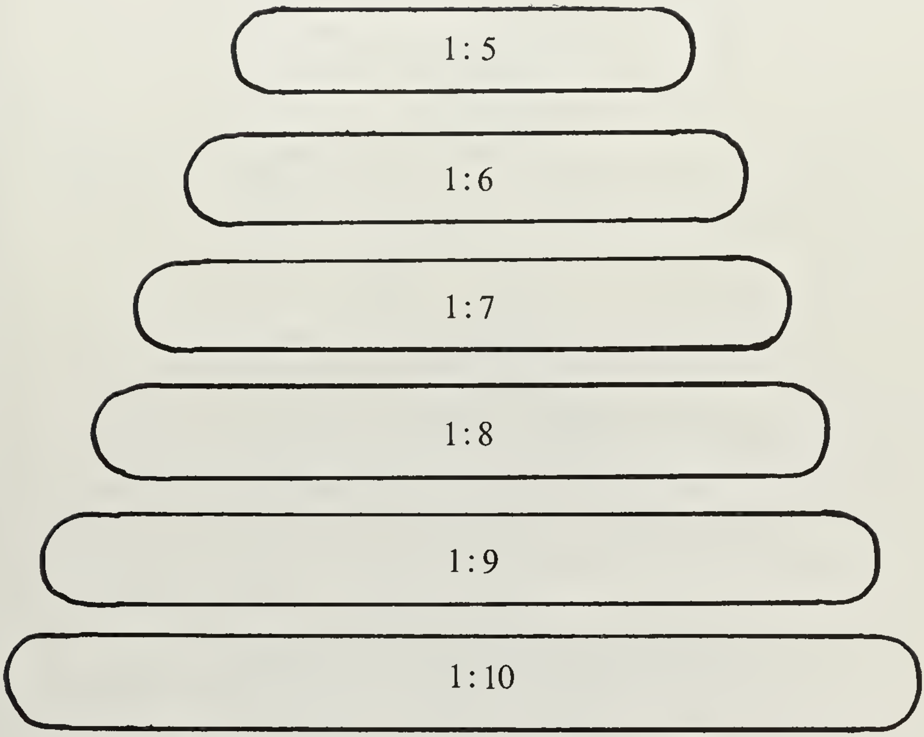


Swept wings



Forward-swept wings

Airplane wings are made in many shapes to provide the right amount of lift for each craft. The distance from the leading edge to the trailing edge is called the chord.

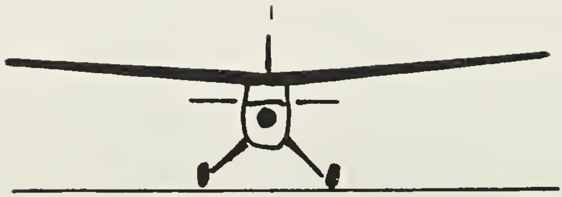


Powerplane *Sailplane*

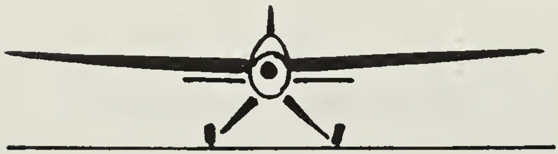
The relationship between an airplane's wingspan (WS) and the wing chord (C) is known as the aspect ratio (AR), computed by the formula:

$$AR = \frac{C}{WS}$$

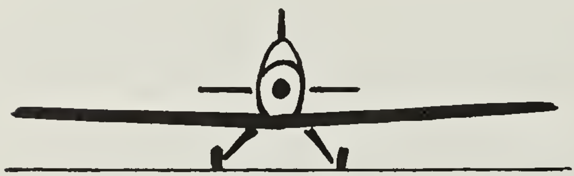
This ratio varies considerably with different kinds of airplanes. For a powered plane, the AR is between 1:7 and 1:8, while for a sailplane, the ratio is from 1:12 to 1:30.



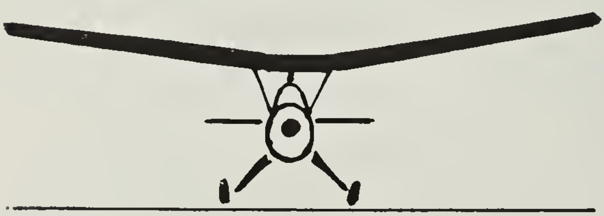
High wing



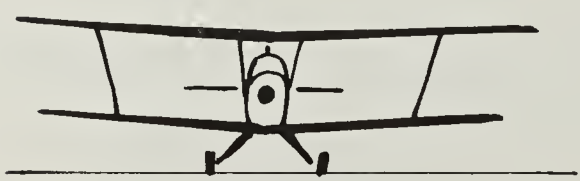
Shoulder wing



Low wing

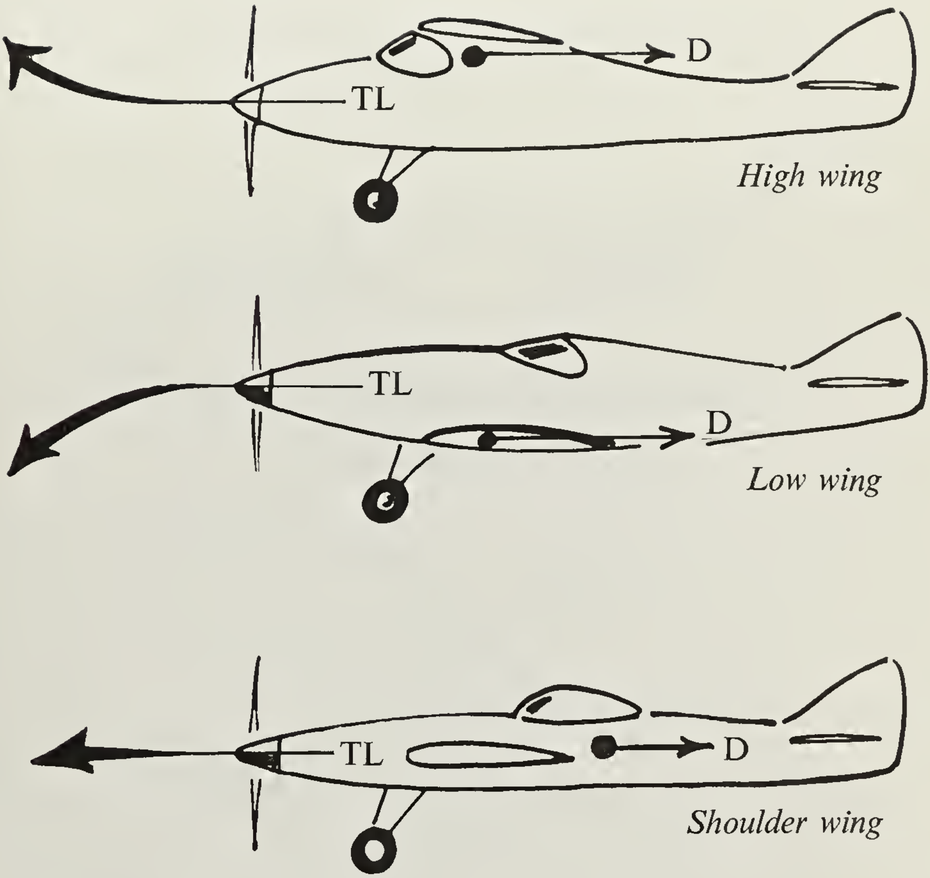


Parasol wing

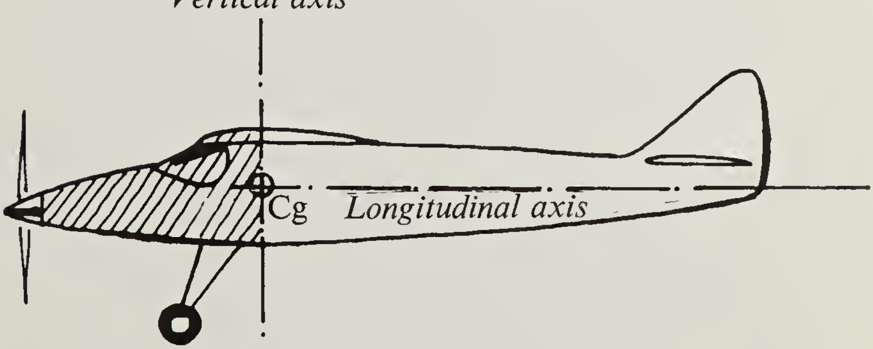


Biplane

Different wing mountings provide varying amounts of stability. The parasol wing gives the greatest stability, a low wing the least.



Forward thrust has a different effect on high-winged, low-winged and mid-winged planes. An imaginary line through the propeller axis is the thrust line (TL).



An airplane's stability depends also upon the proportion of the body ahead of and behind the center of gravity.

Dihedral or V-shaped wings

Straight wings with angled tips

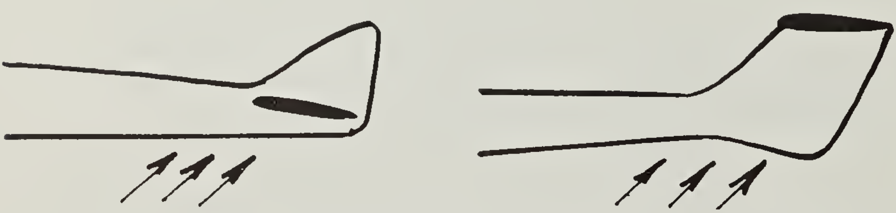
Dihedral wings with angled tips

Gull wings

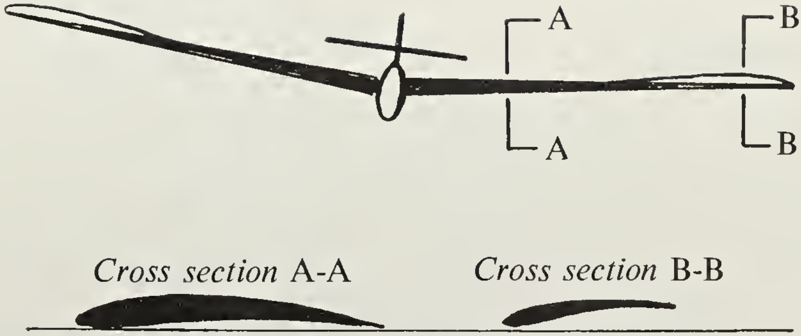
U-shaped wings

Upside-down V-shaped wings with angled tips

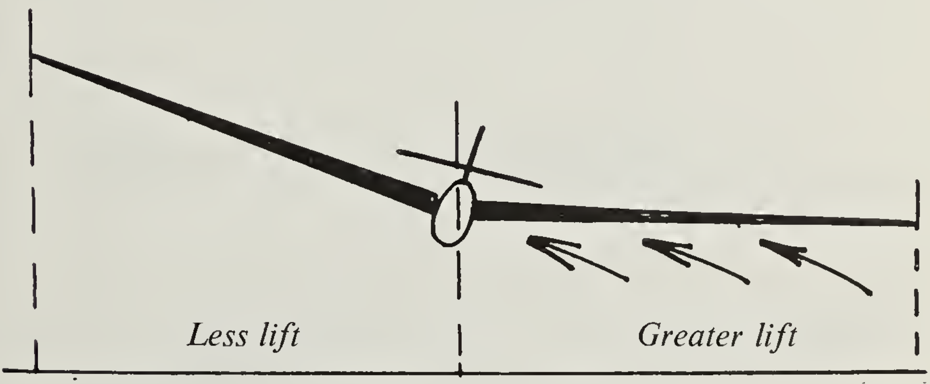
Various wing forms provide good stability.

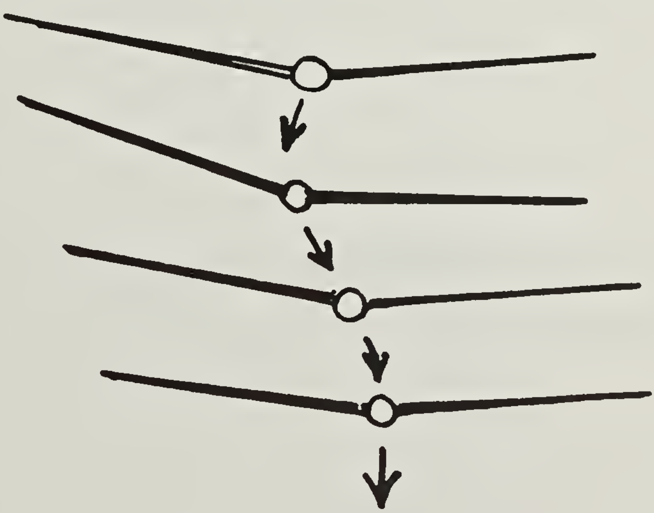


In certain situations, the tailplane can block the fin and rudder, interfering with stability. A T-tail arrangement will prevent this.

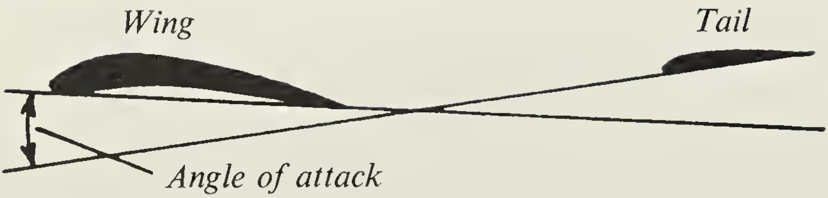


Constructing wing panels with a built-in warp increases stability. This shape is called "wash-out."

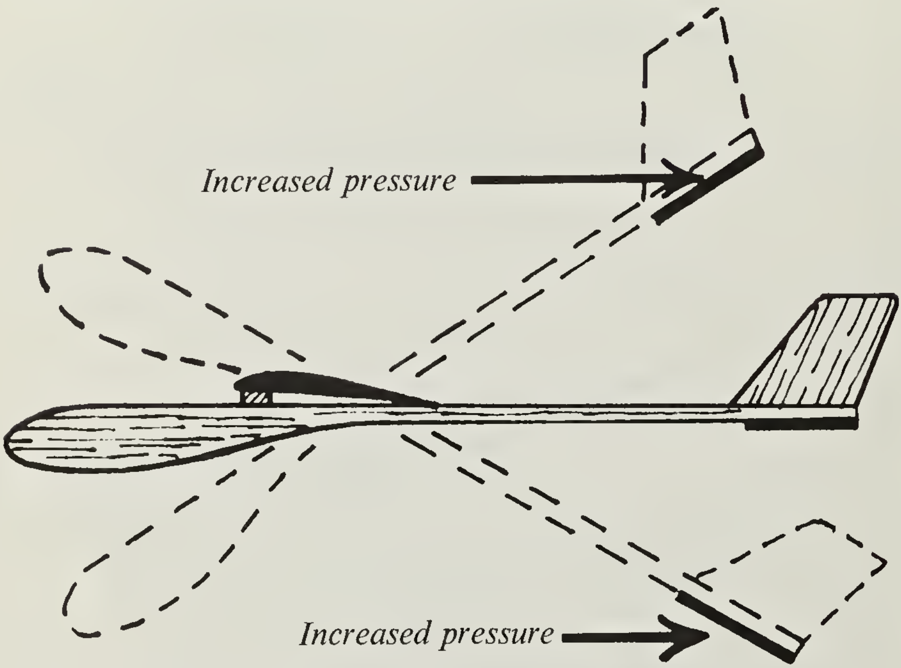




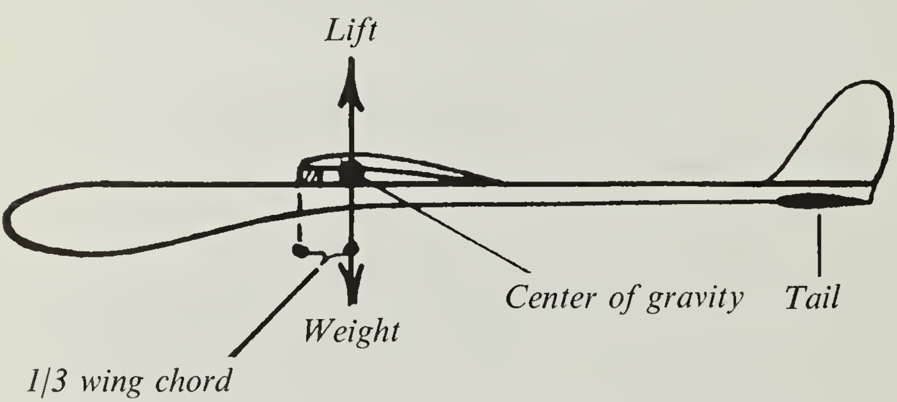
A wing's upwards or downwards inclination is called the dihedral angle. The dihedral also helps to stabilize a plane.



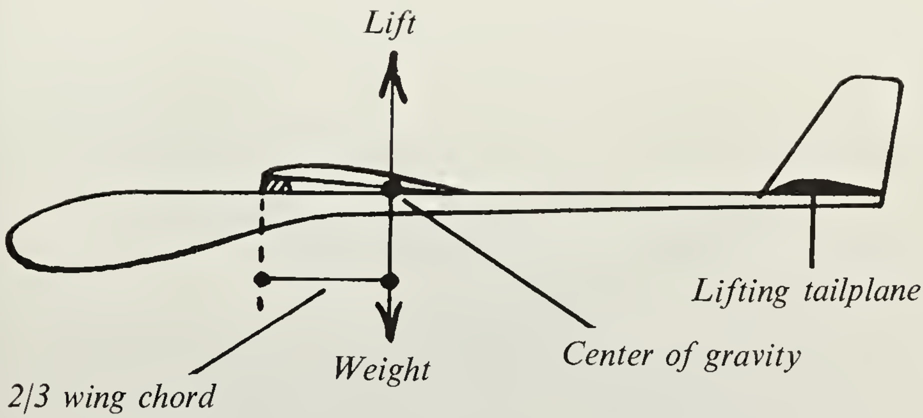
Stability is also affected by the air stream's angle of attack.



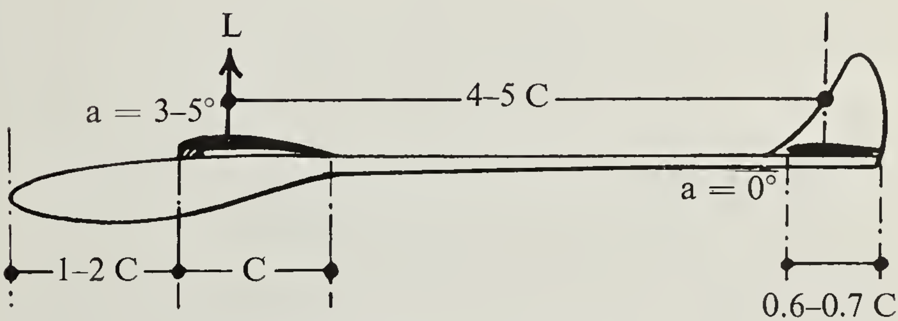
An airplane's tail stabilizes it along its lateral axis.



When the tail of an airplane is level, the center of gravity will be 1/3 the length of the wing chord back from the leading edge of the wing.

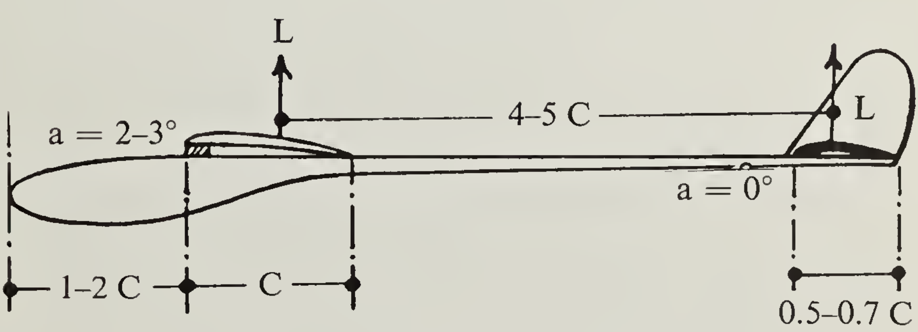


When the tail lifts, the center of gravity will be 2/3 the length of the wing chord back from the leading edge.

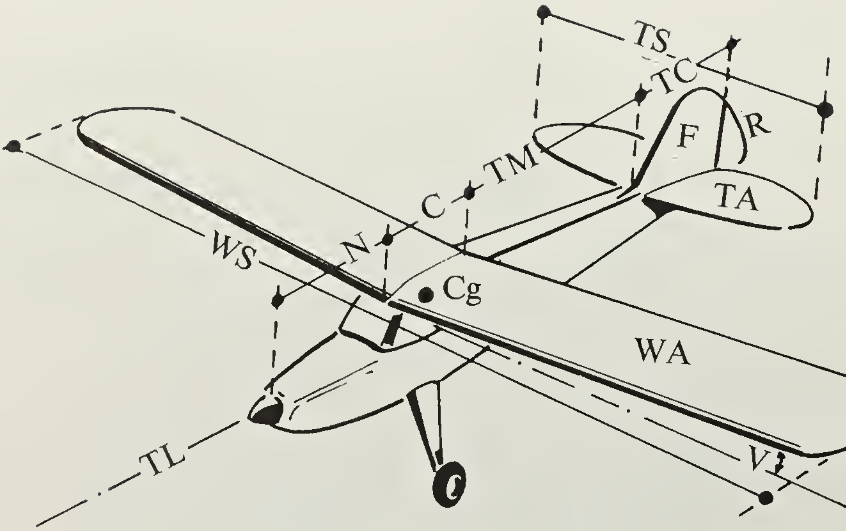


Momentum with a level tailplane

C = *Average wing chords*



Momentum with a lifting tailplane



Here are some general proportions for a free-flying powered model. This type is also good as an RC-trainer.

ABBREVIATIONS

WS = Wingspan
WA = Wing area
C = Wing chord
V = Dihedral (V-form) angle
TS = Tailspan
TA = Tail area
TC = Tail chord
F = Fin
R = Rudder
TM = Tail moment arm
TL = Thrust line
N = Nose length
Cg = Center of gravity

PROPORTIONS

WS depends on motor displacement.
TA is 25 to 30 per cent of WA.
F+R is 8 to 10 per cent of WA.
TS is 25 to 35 per cent of WS.
N is 60 to 75 per cent of C.
C is 10 to 14 per cent of WS.
TM is 200 to 250 per cent of C.
M is 2 to $2\frac{1}{2}$ C.
TC is 35 to 40 per cent of C.
Cg is 30 to 35 per cent of C.
TL is 2 to 3° down, 1 to 2° right.
V is 5 to 8°.

Tools

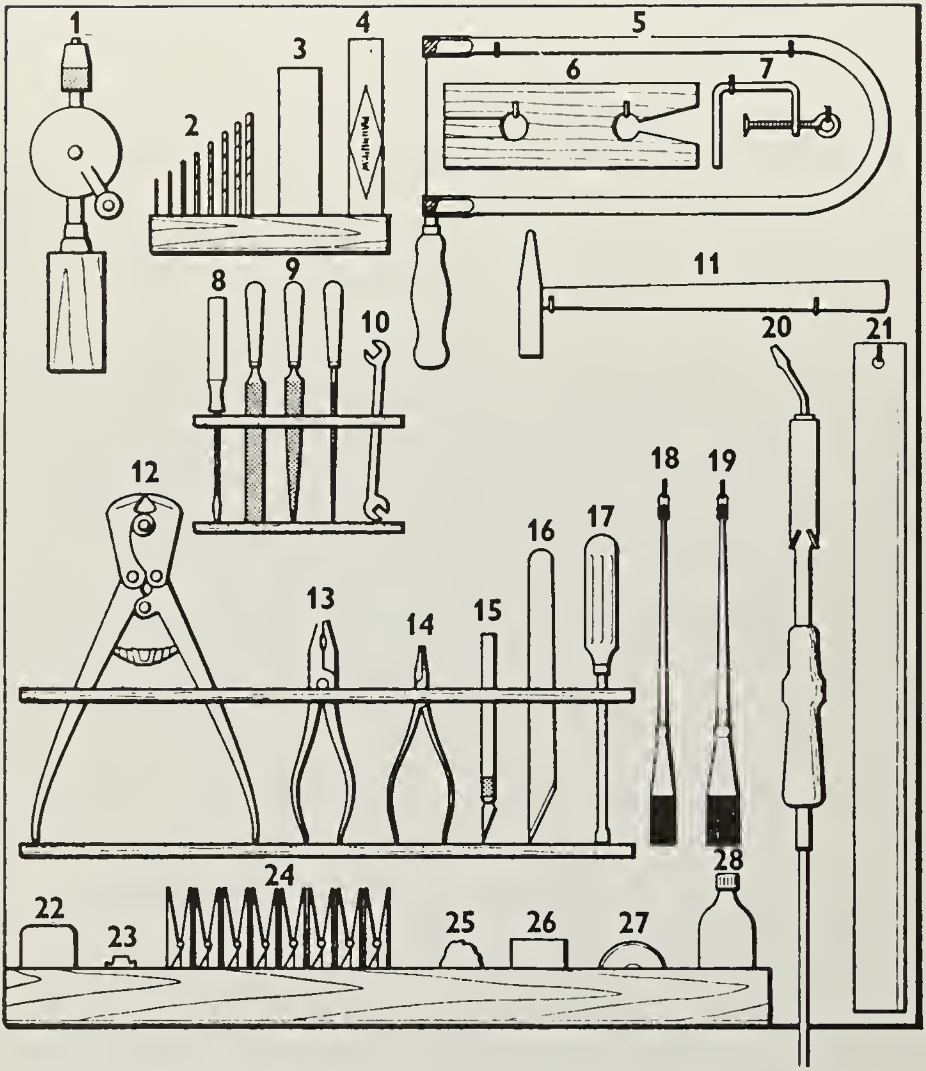
An experienced model builder can make any model using only a razor blade, ordinary pins, glue and a work table. Of course, building model airplanes that will fly is not so simple, but it is truly surprising what you can do with just a little equipment. Simple models call for only a few basic tools. If you start with kits, as most beginners do, some of the parts will be ready-made for you. When you graduate to larger, more complicated models, you will need a greater assortment of tools to do the job. If you are a serious model builder, the equipment described below represents the basic items you will need—experts will have more. In getting started, however, it is just as well to buy tools only as you need them over a period of time.

Work Board. The most important item is your work board. It should be perfectly flat and made from soft wood; otherwise you will bend the pins when you try to push them in. A large artist's drawing board is ideal for model building. These are available in sizes ranging from 20×16 inches to 70×50 inches (50×40 cm. to 180×125 cm.). Buy the largest that you can afford and have room for.

You can, of course, make your own work board from pine or other soft wood. It must, however, be truly flat, straight-grained, and free from knots.

Regardless of the type of work board you choose, you should paint or stain it a dark color. Small pieces of balsa and pins show up clearly against a dark background and are not so easily lost or misplaced.

Knife and Razor Blades. Since you will be working with a variety of woods, you should buy a quality knife right away. Many commercial brands are on the market, and it pays to ask your hobby dealer for advice on which one to buy. For building



Illus. 6. A well-stocked tool case for the experienced builder. The tools are identified on the next page.

A Well-Stocked Tool Case

1: hand drill
2: drill bits
3: sharpening stone
4: blades for scroll saw
5: scroll saw
6: bench pin for scroll saw
7: clamp
8: small screwdriver
9: assorted files
10: engineer's double-headed wrench
11: hammer
12: heavy-duty wire cutter
13: square pliers
14: round-nose pliers
15: small knife
16: utility knife
17: heavy screwdriver
18: small brush
19: large brush
20: soldering iron
21: steel ruler
22: box of pins
23: center punch (or hole puncher)
24: wooden clamps
25: steel wool
26/28: soldering chemicals
27: soldering tin

This list of tools will give you some idea of the variety of equipment you may eventually want to buy, adding to your collection as you become more accomplished at model building. Invest your money in quality tools, and only in those that you need—no more. Remember that you, and not the tools, make the model—it is your skill, imagination, and patience that will insure success.

models, a solid-handled knife with interchangeable blades is best. You will also need a variety of blades of different shapes. Keep a supply of single-edged razor blades at hand as well. Use the thickest type available.

Saws. You will most often use a coping saw, small hacksaw, and scroll saw. Have an assortment of fine and coarse blades to fit them.

Plane. The small type is best, so you can use it in tight areas.

Files. You will need flat and round files for both wood and metal work.

Drills. Small drills are the most useful, especially the range between $\frac{1}{16}$ and $\frac{1}{4}$ inch (1.5 and 6.0 mm.). Buy drills for boring both wood and metal.

Pliers. You will need a pair of good quality, heavy-duty wire cutters capable of cutting steel wire up to 16 or 14 Standard Wire Gauge (S.W.G.). Square and round-nose pliers are also useful.

Wood Rasp and Sandpaper. A solid rasp for wood and sandpaper of different grades are essential. You can make a suitable sanding block from a piece of balsa wood $2 \times 2 \times 1$ inches ($50 \times 50 \times 25$ mm.). Blocks in other sizes may also be necessary.

Clamp Vices and Pins. Ordinary household steel pins and some lightweight clamps will always be needed in your work.

Hammer and Screwdriver. You will need one of each, generally a small size.

Electric Soldering Iron. A medium-heavy soldering iron of about 75 watts is best. Do not buy the smallest types, which are made especially for radio repair work.

Steel Ruler and T-Square. A 3-foot (1-m.) ruler is adequate—a little bit longer is even better. These are your most valuable tools—buy the best you can and take care of them.

Brushes and Spray Gun. You will need a variety of small flat and round paintbrushes. A good spray paint gun is also nice to have.

Materials

You will use different materials for various parts of any model airplane you want to build and fly. Since you will probably be starting with kit models, most of the materials will already be chosen for you. Even so, the density, strength, and weight of the materials are basic information you must know to be an intelligent and successful builder. You must also understand the fundamental ideas behind model construction to select the proper materials for a job. Of course, theory is more important when you begin to design your own models, but from the beginning, you must have a thorough knowledge of the characteristics of the materials that you will use.

Balsa Wood

Balsa wood is the main building material used in model airplanes. It is very light and the strength-to-weight factor is good. It is classified hard, medium or soft, with hard balsa the heaviest and soft balsa the lightest. Choose from the various grades depending on the strength that the particular model requires. The fuselage of any plane must be built from fairly hard balsa for strength, while the tail section (which must be kept as light as possible) should be built of light balsa.

Hobby shops sell balsa in many different sizes. You can choose from such a broad selection in hobby shops that it is seldom necessary for you to plane or saw it yourself. The most popular strip sizes are $\frac{1}{16}$-, $\frac{3}{32}$-, $\frac{1}{8}$-, $\frac{3}{16}$-, and $\frac{1}{4}$-inch (1.5-, 2.0-, 3.0-, 4.5-, and 6.0-mm.) square sections. Flat sections of $\frac{1}{16} \times \frac{1}{4}$ inch or $\frac{1}{8} \times \frac{1}{2}$ inch (1.5×6.0 mm. or 3.0×12.5 mm.) are also available. Pieces which are 1-inch (25-mm.) square or larger are classified as "blocks." You can also buy "sheets," which

are usually 2 or 3 inches (50 or 75 mm.) wide and 12 inches (30 cm.) long.

A model airplane built from balsa wood must be sanded carefully before doping and covering.

Spruce and Pine

These woods are some 3 to 4 times heavier than balsa, with a proportionate increase in strength. Spruce and pine are mainly used in model airplane parts where strength is essential—for instance, the main spars in the wings of larger models. You must avoid knots or other weak spots that are often found in these woods. Take care when sanding a model in which balsa has been used together with spruce or pine since the latter woods are so much harder than balsa.

Ash and Beech

Ash and beech are 2 to 4 times heavier than balsa. They are generally used in small amounts for engine mounts, power propellers or nose blocks.

Plywood

This thin, high-quality bonded material is sold in small panels $\frac{1}{32}$ inch (.75 mm.) thick, or thicker. Often referred to as "aircraft ply," it is very strong and is used to reinforce bulkheads and heavy-duty wing ribs. You need a good saw to cut thin plywood, and be very careful when you sand it.

Piano Wire and Other Metals

Thick spring-steel wire, $\frac{1}{16}$- to $\frac{1}{8}$-inch (1.5 to 3.0 mm.) in diameter, is used for landing gear structures and rubber-powered propeller shafts. Medium wire ($\frac{1}{32}$ to $\frac{1}{16}$ inch or .75 to 1.5 mm.) is used for rubber-powered models and control-line models. Wire as thin as .006 inch (.15 mm.) is used for control lines and for small springs.

Brass, aluminum and duralumin in sheet, strip and tubular form are also used for many purposes in large models. However, always keep the weight factor in mind.

Glue and Cement

Glue is one of the most important materials for all model building. You will find a large selection for many different purposes in your hobby shop. The glue you will use most often is quick-drying cellulose.

Ordinary white glue is also useful and popular. It is slow drying, and thus enables you to correct a poor join several minutes after making it. For plastic materials and fiberglass, you will use different epoxy glues. Always prepare epoxy glue strictly according to the instructions which accompany it.

Dope

The framework of a model may be "doped" before or after you cover it with the airplane's skin. This will help waterproof and protect the plane's structure. Dope handles in many ways like thinned cellulose glue. You can buy dope either clear or in colors, and you should always use a good quality brush to paint it on. Colored dope is somewhat heavier than clear dope.

Acetone

Acetone is used to thin out dope and glue. It is also a solvent, good for cleaning your brushes and removing unwanted paint spots from the model. Acetone is quite inflammable and dangerous if inhaled. Therefore, keep the bottle tightly capped and safely away from small children. Never leave a bottle of acetone on the floor or on your work table where a child can reach it.

Covering Materials

Today, you can choose from a wide variety of covering materials—special tissues, silk, nylon and plastic sheets. The application of these covering materials depends on the type of model and your own personal preference. Generally, the tissues are used for smaller, free-flight models. Silk and nylon are heavier and far stronger than tissue, but they also require a

stronger framework. Plastic sheets that shrink to fit, for instance "Monokote" or "Solar-film," are becoming increasingly popular. These last do not require any dope or glue—they will stick to the framework and shrink to the tightness of a drumhead with the application of heat from an iron.

Power Sources

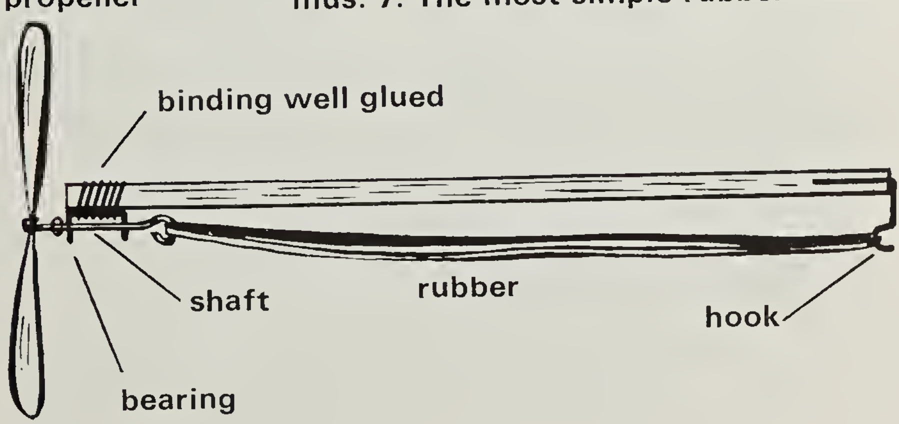
The common power sources or engines for model airplanes today are the rubber "motor," the diesel motor, and the glow or glowplug motor.

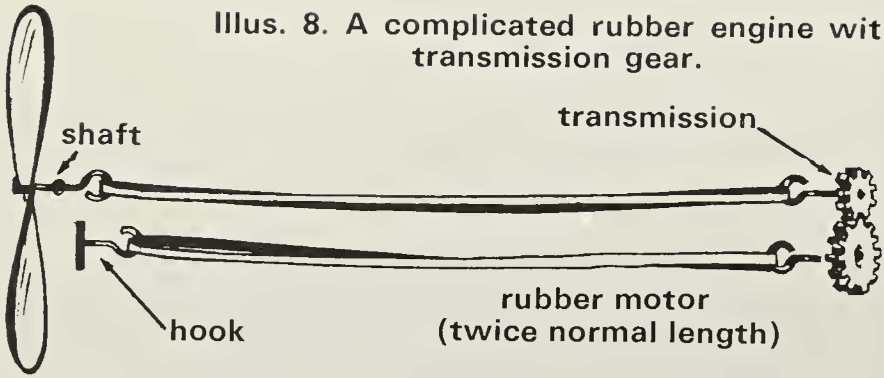
The Rubber Motor

This is the oldest and simplest model airplane motor. It consists of one or more rubber bands which run between the propeller shaft and a hook in the aft (rear) section of the fuselage. By turning the propeller around with your finger, you twist the rubber loops more and more, achieving considerable torque. The rubber loops accumulate energy which is converted to propeller energy the moment you set the propeller free. The power you obtain is proportional to the number of turns that you give the propeller during the "wind-up."

A rubber motor can be either very simple like the one in Illus. 7, or more sophisticated, like the device shown in Illus. 8,

Illus. 7. The most simple rubber motor.

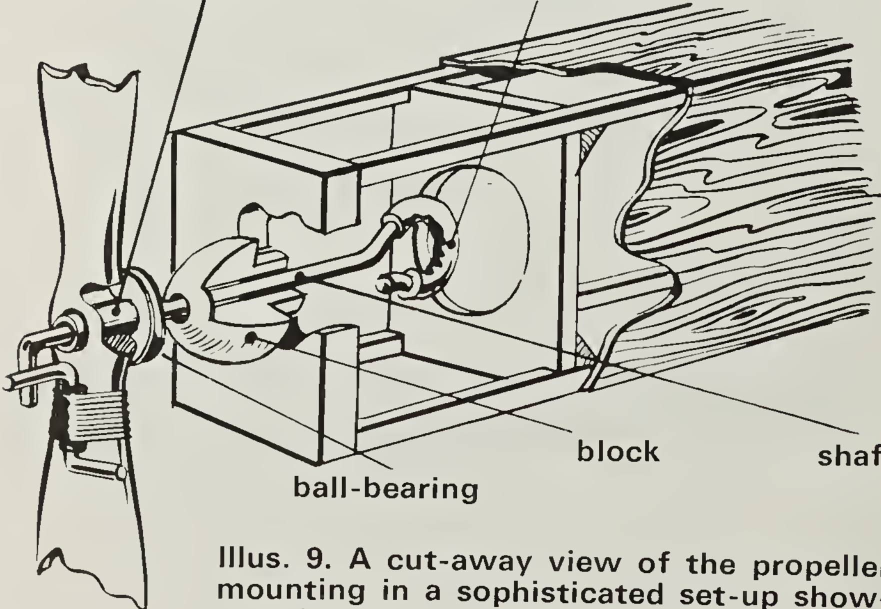




Illus. 8. A complicated rubber engine with transmission gear.

with transmission gear and a free-wheeling propeller. Either motor will give you good, faithful service if you treat it correctly.

To make a motor, first cut the rubber to the appropriate width and length and then lubricate it with a soft oil. You now "trim" it, which is simply stretching and re-stretching the rubber until you can turn it the maximum number of times and thus get the greatest possible energy delivery from it. There are a number of trimming methods. This is the simplest:



Illus. 9. A cut-away view of the propeller mounting in a sophisticated set-up showing the free-wheeling propeller.

Illus. 10. Use this knot to join the ends of a rubber band.

1. Fasten the end of the length of rubber to a door handle and stretch it to approximately 3 times its original length.

2. Turn it 50 times and then let it unravel, still holding the end.

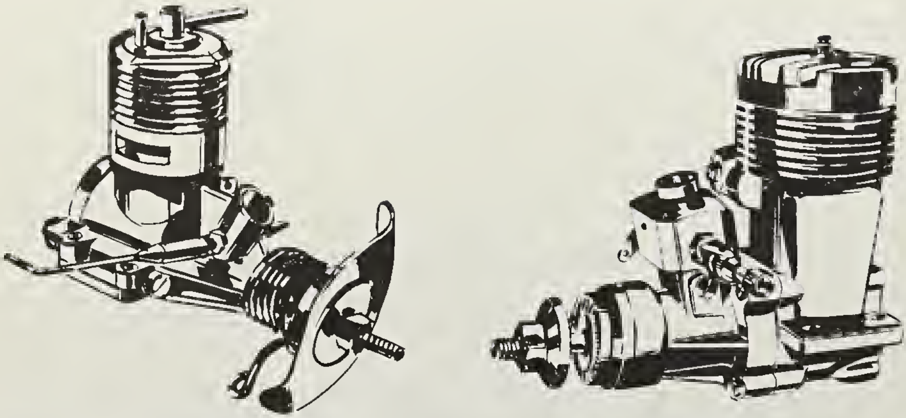
3. Let the rubber relax for a minute, then stretch it as before, giving it 75 or 80 turns. Again, let it unwind while keeping it taut.

4. Let it (and you) relax for a minute, and then give it 50 turns as you stretch it and 45 or 50 additional turns as you gradually relax the lengthwise stretch. Repeat the original procedure, this time giving it 125 turns.

Continue this process, increasing the "wind-up" each time by 25 per cent until you obtain the maximum number of turns for that particular length of rubber. You can calculate this maximum number by using the following table:

Number of loops	4	6	8	10	12	14	16	18	20
$\frac{1}{8}$-inch width	64	52	44	40	36	32	29	27	25
$\frac{3}{16}$-inch width	48	44	32	33	30	28	25	22	19
$\frac{1}{4}$-inch width	44	36	29	26	23	22	20	18	16

Find the column which shows the width of the strip of rubber you are using. Now follow this column across until you find the corresponding number in the column which indicates the number of loops you have made from the total length. By multiplying the number from the table by the total length of the rubber strip, you arrive at the maximum number of turns for that particular rubber-powered motor. For example, if you are going to twist a $\frac{3}{16}$-inch-wide rubber strip, 20 inches long, using 10 loops, you will be able to achieve a maximum of 20 (inches) $\times$ 33 (number from table) = 660 turns. (If you are working in centimeters, just divide the length of the rubber strip by 2.5 before multiplying by the number from the table.)



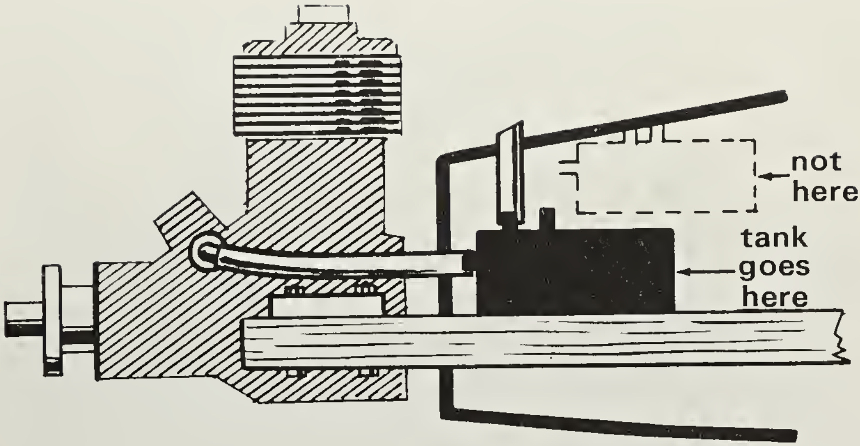
Illus. 11. The diesel-fed motor (left) and the glowplug engine (right) are the most popular in use today.

Diesel and Glowplug Motors

These two types of engines are the most commonly used in model airplanes. Both types are normally single-cylinder, 2-stroke engines with a cylinder volume of .12 to .6 cu. in. (.2 to 10 cc.). In the diesel motor, the fuel is ignited by the high compression created in the cylinder by the piston. The glowplug motor has a small glowplug which, before the start, is heated by using a small battery. The glowing plug then causes ignition, and the battery leads are removed. The glowplug now keeps glowing because of the heat from each ignition and the motor runs happily.

Starting one of these motors can be difficult for a beginner. The following tips should, however, be of help. First of all, you should always break in a motor before you want to actually use it. This breaking-in period may vary from a few minutes to 1 or $1\frac{1}{2}$ hours, depending on the type and size of the motor and the manufacturer's advice. Read all of the directions that come with the motor before you do anything! Generally you should not run a motor more than 3 or 4 minutes the first time. Then, repeat this 3 to 5 additional times. Be careful not to overdo it.

Of course, you must mount the motor securely before you try starting it. Use solid machine screws and a solid piece of plywood at least $\frac{1}{8}$ inch (3 mm.) thick. When the motor and tank are fastened, connect the tubing between the fuel-inlet of

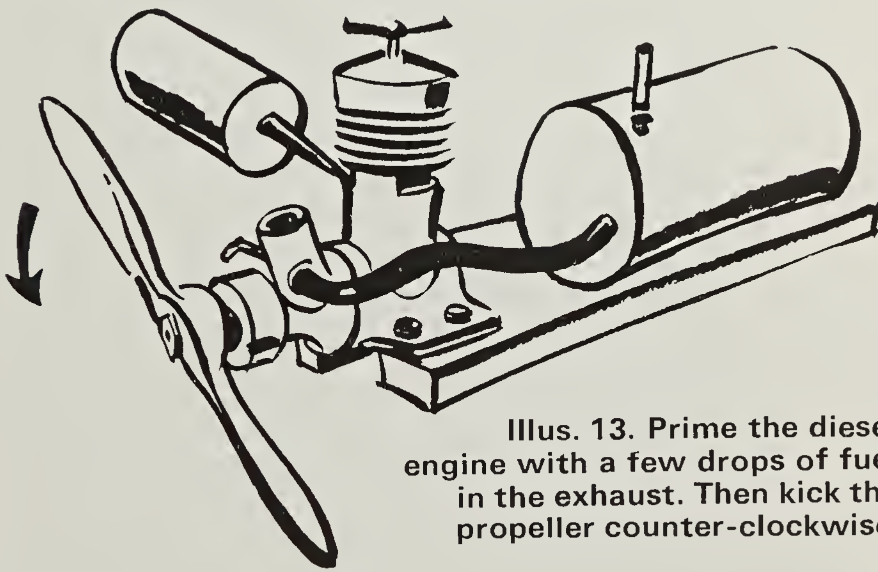


Illus. 12. Mount the fuel tank on the same level as the motor so that your engine draws the fuel by suction.

the motor and the fuel tank. Be sure to check that the tank and fuel-inlet are on the same level (see Illus. 12). The fuel must not be allowed to flow freely down into the motor. The motor should produce enough suction by itself to draw fuel from the tank.

STARTING A DIESEL MOTOR

Put diesel fuel into the tank. Choke the motor by holding your finger tightly over the air-intake while you turn the



Illus. 13. Prime the diesel engine with a few drops of fuel in the exhaust. Then kick the propeller counter-clockwise.

propeller counter-clockwise 2 to 4 times. (The fuel should be visible in the tubing and fuel-inlet.) Squeeze a little fuel from your fuel bottle into the exhaust ports—just a few drops will do. Now, your diesel motor is ready to start.

With your finger, flick the propeller quickly counter-clockwise. The motor should start after a maximum of 6 to 12 tries. If it does not, increase the compression a little by turning the compression screw 1 or $1\frac{1}{2}$ turns clockwise. Repeat the starting procedure, and the motor should start up. (You may also have to adjust the fuel needle to increase or decrease the amount of fuel let into the motor while running. This procedure is not difficult but does require some experience.) Always be careful around the motor and propeller—take care of your fingers!

STARTING A GLOWPLUG MOTOR

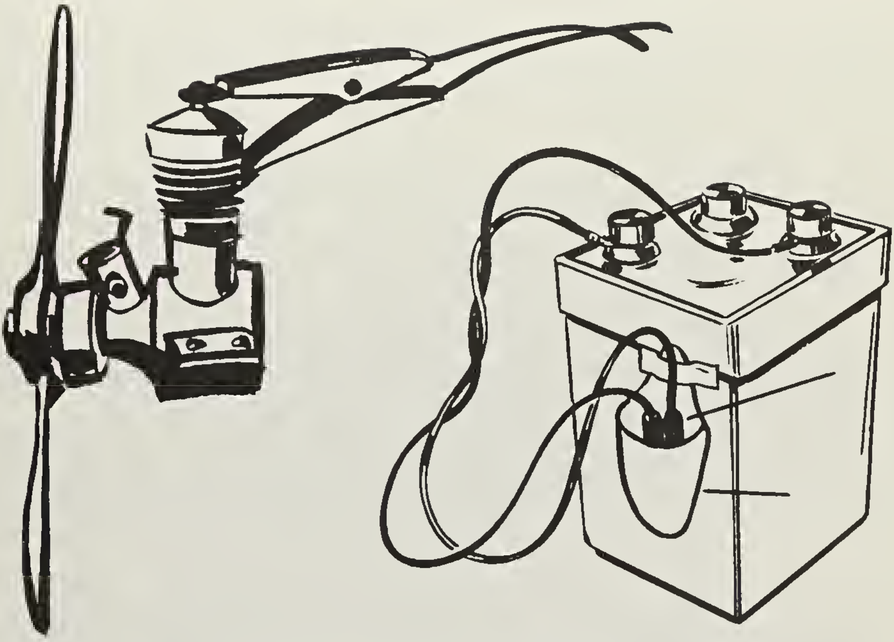
For this, you need the proper fuel, a 1.5-volt starter battery, a starting cable with clips, and, of course, a mounting platform for the engine.

Begin by connecting the battery to the glowplug. Check to see that the plug really glows—the glow coil should be red (you will sometimes be able to see this through the exhaust ports). You may also hear the plug heat, because the moisture on the coil will burn off, causing a low, crackling noise.

Squeeze a few drops from your fuel bottle into the exhaust ports and the fuel-intake. Turn the propeller quickly with a smart flick and it should start up immediately. Now, with the fuel needle, adjust the motor until you hear an even, purring sound. The glowplug motor runs at a considerably higher rate of revolutions per minute (r.p.m.) than the diesel motor, producing a much higher tone.

If the motor will not start, try squeezing more fuel into the exhaust ports and the fuel-intake and repeat the starting procedure. Remember, the battery should be connected only during the starting and adjusting procedures. Disconnect it as soon as the motor runs steadily. Keep the battery, cables and clips well away from the motor. Do not short-circuit the battery by careless use of the clips.

A glowplug motor is harder to start in cold weather, because



Illus. 14. The position of the battery clips on the glowplug motor. They are safely stored with the battery.

the battery does not keep its full power as the temperature drops. The glowplug then gets too little voltage and will not deliver the needed starting kick. Use a storage, or accumulator battery instead of a dry cell in winter. A storage battery is, in any event, cheaper to run over a long period of time.

Propeller

Your choice of propeller is also very important for the efficient use of a motor. You must consider the motor itself, its displacement, and how you want it to perform.

A propeller is normally referred to by a two-digit designation —for example, 8×6. This means that this propeller is 8 inches in diameter and has a pitch of 6 inches. The "pitch" is the horizontal distance the propeller will screw forward in one complete revolution, in this case, 6 inches.

The pitch number is quite useful in further calculations. You can use it to determine the theoretical speed that any combination of motor and propeller will deliver. For example,

if you put the propeller in question on a U-control plane and spin it at a rate of 15,000 r.p.m., the theoretical speed of the plane should then be:

$$\frac{6\text{ (inches)} \times 15{,}000\text{ (r.p.m.)} \times 60\text{ (minutes per hour)}}{12\text{ (inches per foot)} \times 5{,}280\text{ (feet per mile)}} = 85.2\text{ m.p.h.}$$

If you want to calculate the speed in kilometers per hour you use essentially the same formula, keeping in mind the change from English measure to the metric system:

$$\frac{6\text{ (inches)} \times 2.54\text{ (cm. per inch)} \times 15{,}000\text{ (r.p.m.)} \times 60\text{ (min./hr.)}}{100{,}000\text{ (cm. per kilometer)}} = 137.16\text{ km./hr.}$$

Whichever system you use, keep in mind that the speed you determine is only theoretical. The drag on the plane reduces the speed considerably, anywhere from 15 to 40 per cent of the figure you calculated, depending on the model, its finish, and other factors. For practical purposes, you should count on a 30 per cent reduction from the calculated theoretical speed for the true speed. In the above case then, the U-control plane will fly at approximately 60 miles or 96 kilometers per hour.

When you choose a propeller, remember that a smaller diameter propeller will give more revolutions per minute and thus a higher theoretical and actual effect. Within natural physical limits, the speed of the plane will increase with the increase in effect. If you choose an 8×8 propeller instead of one that is 8×6, for a specific motor, you will obtain less effect and, consequently, less speed. This can be very bad for a heavy plane. Choosing the correct propeller is very important in order to get the best performance from your plane.

Fuel

The fuel you use is also important. A number of mixtures are available for both diesel and glowplug motors. The engine manufacturer will normally tell you which "soup" is best for each motor. Stick to the recommended mix until you become an expert. Today, very few people mix their own fuel. For the

inexperienced pilot, a pre-mixed fuel is definitely best. Just remember that a diesel motor cannot run on glowplug-motor fuel, and vice versa.

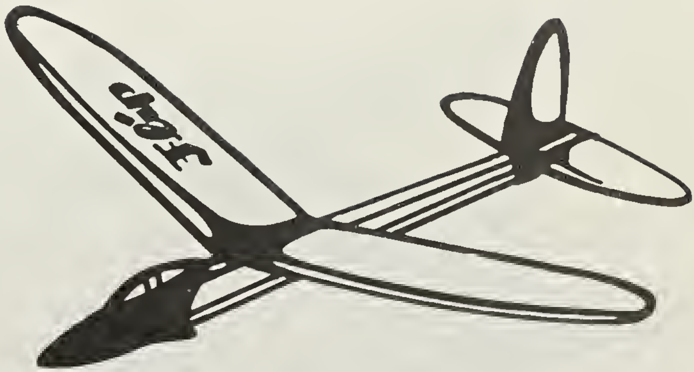
The model airplane engines of today are nothing less than masterpieces of mechanical engineering. This chapter deals only with the basic types—no mention has been made of the sophisticated motors with throttle-devices, silencers, or self-starting mechanisms. These advanced machines are best left until you have gained a little flight time. In the beginning stages, you only need the basic facts about motors and how to handle them. If you care for them properly, you will be well rewarded.

Advice for the Beginner

Being a novice is not easy in any sport or hobby. In building model airplanes, problems frequently arise at the start. Without the right help and instructions from an experienced model builder, you may be tempted to give up after your initial effort. This book aims to provide you with just the advice you need to overcome those first hurdles and help you before you become too discouraged.

Many beginners go wrong right away by choosing the wrong model. Do not select a complicated and ambitious scale-model reproduction of a World War II Mustang or a Thomson racer for your first project. If you overestimate your skill, you will likely be frustrated by the unforeseen difficulties of such a complex project. This will result almost inevitably in a quick return to your work table after a heartbreaking crash on the flying field. You are then faced with the even more discouraging prospect of repairing a complicated model that you did not completely understand when you were first constructing it.

Regardless of your age or your individual interests, you should try a simple and functional box-construction model for your first project (avoid any scale models at this stage). Start off with a basic trainer design. You will find that a medium-size model is easy to build, trim, fly, and—most importantly—easy to repair. You can find this type of model without difficulty in your hobby shop, but once again, be careful. Decide what kind of model you prefer: a simple glider, a small rubber-powered model, or perhaps a radio-controlled trainer type. The simplest is usually the best. All beginners would do well to choose a small glider with a wingspan of 20 to 30 inches (50 to 75 cm.) for their first model. This will give you considerable experience in building and trimming the craft, and you will learn some basic aerodynamics and flying techniques. A glider is the best

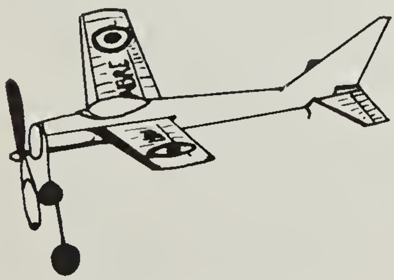


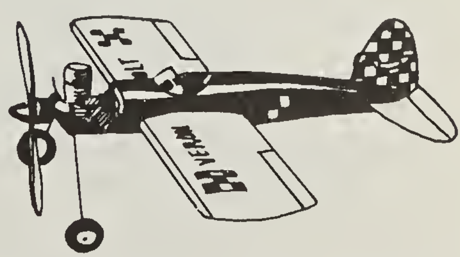
Illus. 15. A glider made from sheet balsa.

basic training for further model building, whether you are interested in free-flight, line-controlled, or radio-controlled models.

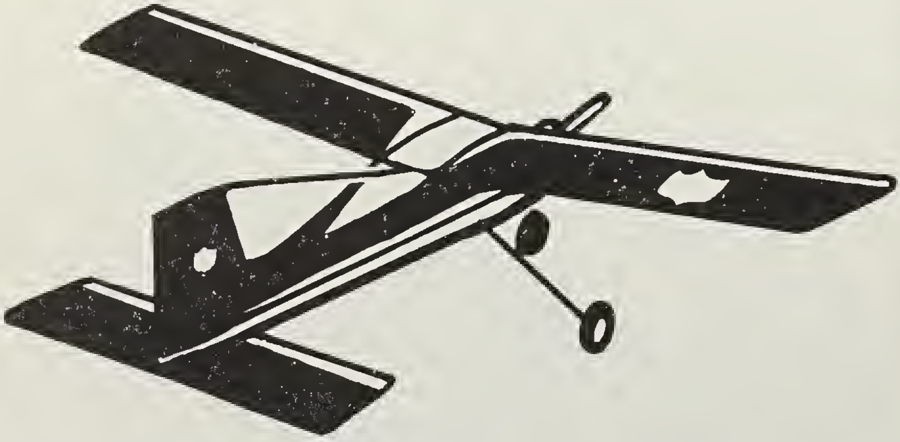
Most novices get the best results by using a kit. If you know any experienced model builders, ask their advice on any particular problems or stumbling blocks. Most model builders are more than happy to share their building secrets. It is also a good idea to compare what you are told and what you read with your own actual experience in building a model.

You should not be too discouraged if your first model fails to soar to the heavens—most beginners do not have their first project in operation for very long. A crash is almost predictable, and very understandable. The best advice is: Do not abandon your first model after a crash and blindly go on to a bigger and newer project. Rather, rebuild your first model or make a





Illus. 16 (left). A rubber-powered plane for the beginner.
Illus. 17 (right). A model like this could be your first line-controlled plane.



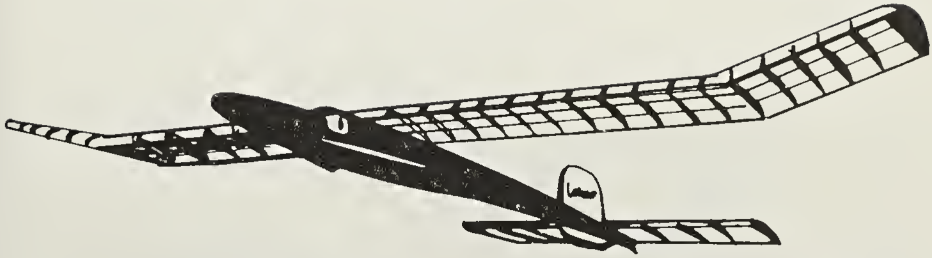
Illus. 18. This high-wing cabin model offers a stable, consistent flight pattern for the novice RC-power pilot.

duplicate of it. This will enable you to study and correct your initial errors, give you additional experience, and be considerably less expensive. Take your time and proceed slowly, one step at a time. Only by following a systematic building and training program will you be able to graduate successfully from the elementary stages of model building.

Models for the Beginner

Understandably, not all beginners will want to start with the same initial project. Be guided by your own interests, but do choose a simple, functional model to start. A small free-flying glider, for instance, is an ideal project for any beginner, above all for those who want to fly free-flight models. It is slow-flying and has a good chance of surviving its first flight. On the other hand, it is pointless to force yourself to build a plane for which you have little enthusiasm.

No matter which category of model airplanes you choose, you will find a great selection of kits and first-class building plans. In most cases, you will be better off with a kit, where you will meet with few, if any, problems during construction. Generally, you will find it easier to achieve a satisfactory end result from a kit rather than from materials which must be cut to size and built up from a plan. You will also find that kits are less expensive in the long run, because there is less waste

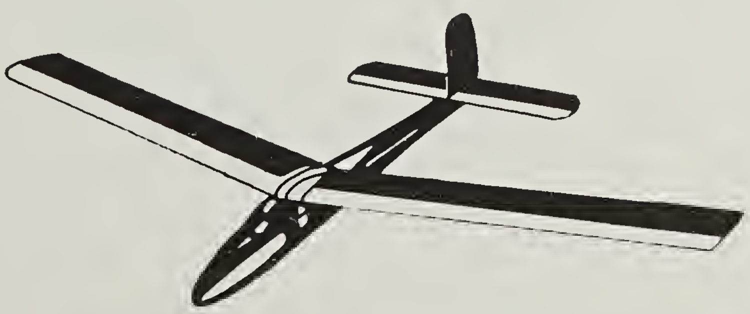


Illus. 19. Cumulus is a steady RC-sailplane that you could use as a free-flight trainer.

of material. (Of course, you should always keep any excess materials for repairs or to build other projects.)

Kits also eliminate some of the more repetitive and often tedious work. The balsa is usually pre-printed or die-cut, so you can begin the actual construction work right away. If you build from a plan, you must first transfer the patterns to the balsa sheets, cut all of the parts accurately, and then sand them to the exact size. You can build a model airplane in a fairly short time if you work from a kit—construction from a building plan usually calls for two or three times as much work.

Whichever type of model airplane you want to fly, you will find numerous basic projects to choose from. Since this selection varies from place to place and year to year, it is impractical to suggest specific models or kits. Look at the various models shown in Illus. 15 to 20. If you find kits that produce models comparable to these planes, you will not go far wrong. Remember also to ask your hobby shop for any advice they can give. But don't rush your choice—seek information and building tips before you buy. You may save more money than you realize.



Illus. 20. When you are ready for RC-sailplanes, choose a large, sturdy model.

Free-Flying Models

Free-flying model airplanes, referred to as FF-models, fly without any kind of steering device manipulated by the pilot on the ground. Free-flying planes are powerless gliders or powered models.

Free-Flying Gliders

Gliders (often called sailplanes or soarers) are, of course, motorless. In any model aircraft survey, the gliders come first. They are the ideal training crafts for model airplane enthusiasts, thanks to the simplicity of their design and their durability in the air.

Gliders can be launched in a variety of fashions:

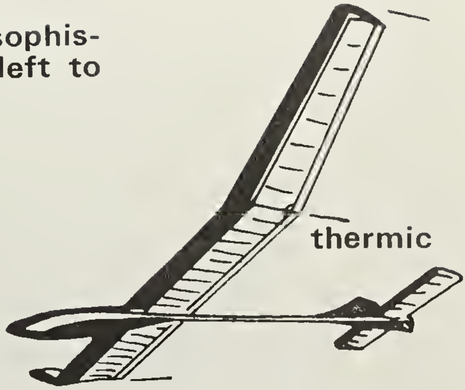
(a) by hand from a hill,
(b) by catapult from a field,
(c) by winch-towing from a field,
(d) by simple towline from a field.

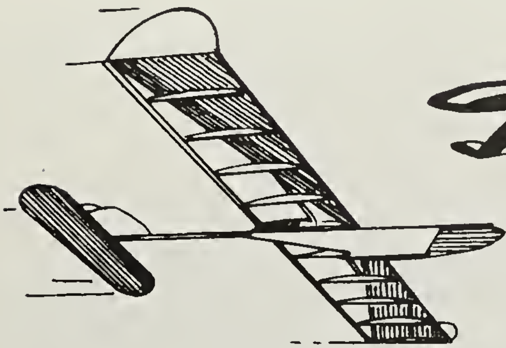
The simple towline method (d) is the most popular, and is the only method allowed in competitions.

Gliders are divided into several classes depending on their wing area, weight, and other variables. Internationally, the A-2 class represents a sophisticated, high-performance plane, a plane you should be able to fly after you have a year or more of experience. The Thermic (Illus. 21) is typical of the A-2 class. It has a wingspan of from $6\frac{1}{2}$ to 7 feet (190 to 210 cm.), a minimum weight of 14.5 ounces (410 grammes), and a total surface area of 495 to 525 square inches (32 to 34 dm.^{2}). A-2 class gliders are not for beginners. Building, trimming, and maintaining such a plane calls for experience.

Instead, try your hand first at a trainer type with smaller overall dimensions. A plane with a wingspan of 2 to 5 feet (60

Illus. 21. Thermic is a sophisticated plane better left to the experts.

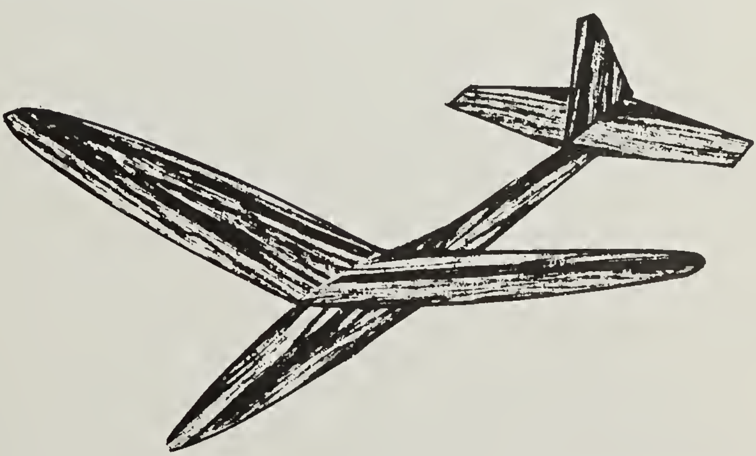




Illus. 22. A plane similar to this with a wingspan of 2 to 5 feet (60 to 150 cm.) could be your first soarer.

to 150 cm.) is much better. Many good kits and building plans are available for planes of this size. A plane like the one in Illus. 22 has simple lines, is easily put together, and can take some punishment—characteristics to look for in a practical trainer.

Simpler, but somewhat more restricted in use, are the very small chuck-gliders, which are usually constructed from solid balsa wood and launched with a strong side-arm throw. Chuck-gliders (Illus. 23) vary in size, with wingspans from 12 to 24 inches (30 to 60 cm.). For youngsters especially, the chuck-glider is the ideal first project.



Illus. 23. A youngster can build a chuck-glider quickly out of balsa wood.

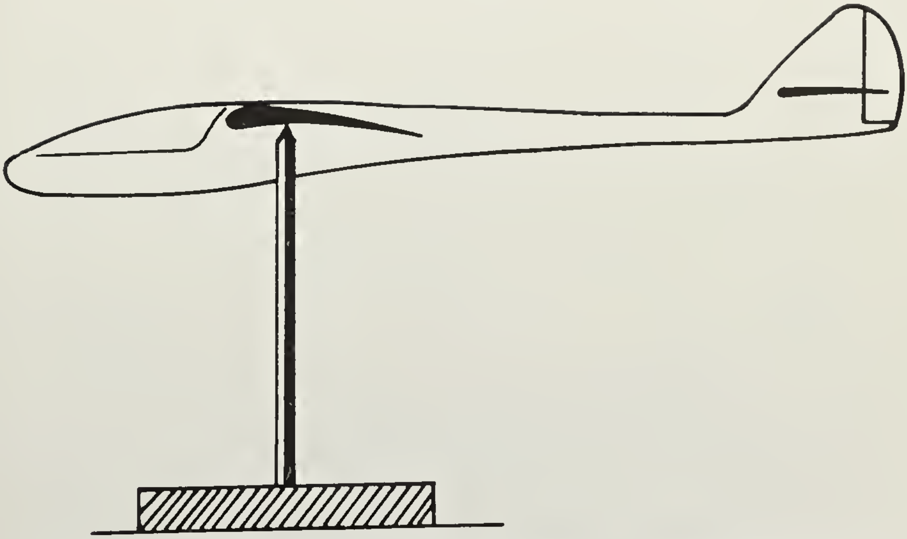
All gliders can be built from kits, or, if you prefer, from detailed building plans. Model airplane magazines often carry plans which you can enlarge and build. Once you have basic experience from building a kit model, you will not find it difficult to make up workable plans from such a drawing (see page 60). Depending on your ability and the time you have to spare for your hobby, you can decide whether to build from a kit or start from scratch with a plan. But the beginner, of course, should avoid this effort and stick to a basic kit.

Trimming a Plane

After you build any plane, you must trim it before you fly it. First, check your model to see if there are any unwanted warps. From in front of the model, look carefully from the wing tips towards the middle of the wing. From behind, check from the tail towards the nose, and from above, look down on the fin. Be sure there are no misalignments. If you do find a fault, correct it carefully. You can, for instance, apply more dope on a twisted wing panel, fasten it again to your building board, and let it dry. Some warps may be so bad that you must overcorrect the mistake and fasten the wing in an "opposite twist" on the building board in order to straighten it. You can also make effective use of the steam from boiling water to "moisten up" a framework that has acquired an unwanted twist (remember, though, that some planes call for a twist in the wings—see page 27). You must correct such a mistake before covering the framework. Hold the framework about 4 to 6 inches (10 to 15 cm.) from the boiling water for 60 seconds while you force the warp out with your fingers and bend the structure back to the correct position and slightly beyond. Hold it there until it dries (5 to 10 minutes), and then put it back on your building board, where you pin it fast. Let it dry completely for at least 24 hours.

CENTER OF GRAVITY

Now, your flying wonder is ready for the final trimming procedure. Before you try a hand launch, you must first check the balance of your model and determine if it has the correct center of gravity (see page 28).

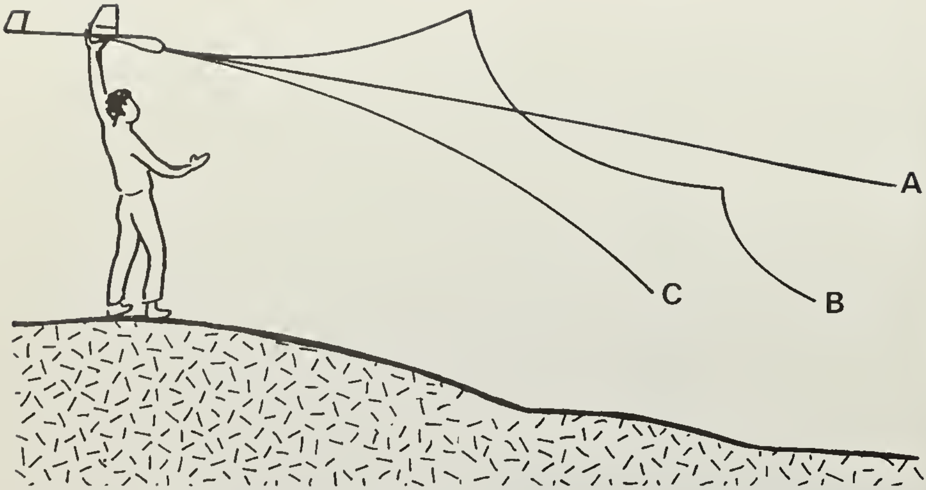


Illus. 24. Your model should balance $\frac{1}{3}$ chord in back of the leading edge of the wing or $\frac{1}{3}$ chord in front of the trailing edge.

Balance your airplane under the wing (Illus. 24). If your model has a flat tailplane (one mounted at zero angle of incidence), place your fingers under a point exactly $\frac{1}{3}$ chord from the *leading* edge of the wing. If the tailplane is a lifting type, the model should balance at a point that is approximately $\frac{1}{3}$ chord in front of the *trailing* edge of the wing. To correct a tail-heavy model, just put some lead into the nose, preferably in a specially arranged "lead-chamber" (most kit models are provided with this space). When your model is correctly balanced, the nose of your model should "hang" slightly.

TRIMMING FLIGHT

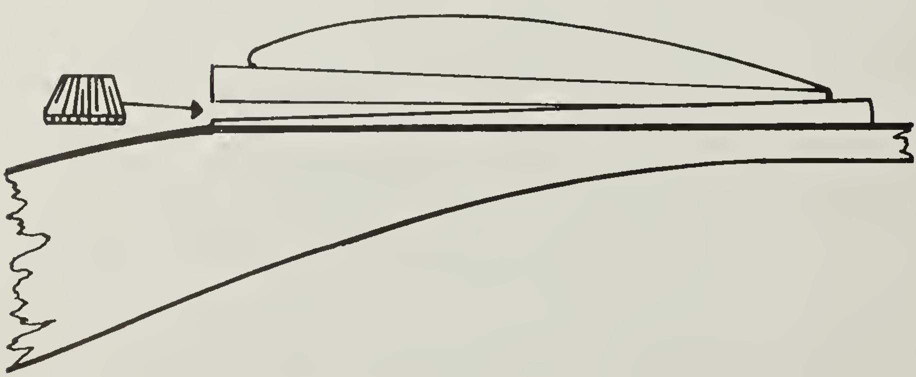
You are now ready for the first trimming flights. Pick a calm day and set yourself up on the slope of a small hill. Hold the model well above your head as shown in Illus. 25. Don't look at the model, but fix your eyes on the horizon or a little below the horizon line. Give the model a decent toss forward and let it go. If you are lucky, your plane is correctly trimmed and will fly in a picture glide to the ground, like path A in Illus. 25. If it is not trimmed correctly, you can expect a bumpy ride, similar to the line described in path B. Here the plane is tail-heavy—put more ballast in the nose. Or you might find that



Illus. 25. Try to get a smooth flight (path A) during your trimming flights.

your model dives too quickly to the ground (path C). In this case, your model is carrying too much weight in the nose—remove ballast gradually until you achieve an ideal flight path.

If your model flies either tail-heavy (path B) or nose-heavy (path C) even though the center of gravity is correct, check the angle of incidence of the wing. For a model which behaves as if it were nose-heavy, pack a bit of balsa under the leading edge of the wing (Illus. 26). Be careful, though—just a thin sliver of balsa about $\frac{1}{32}$ inch (1 mm.) thick at a time. Make several practice flights to check the performance before adding another piece.

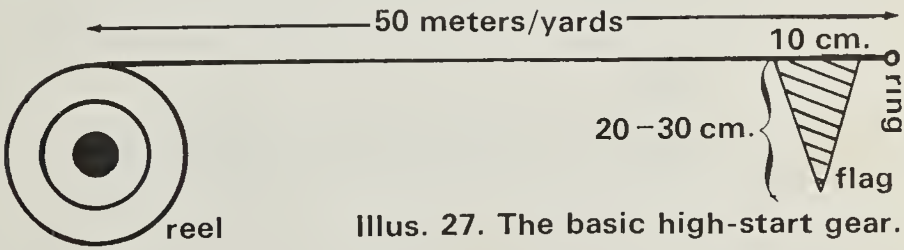


Illus. 26. Pack a thin sliver of balsa under the leading edge of the wing to correct a nose-heavy model.

A model which acts tail-heavy even though it has the correct center of gravity needs an equivalent packing under the trailing edge of the wing. Your goal is to have every flight look like path A in Illus. 25. Since a correct launch is very important in obtaining a smooth flight, make several tests before making any changes.

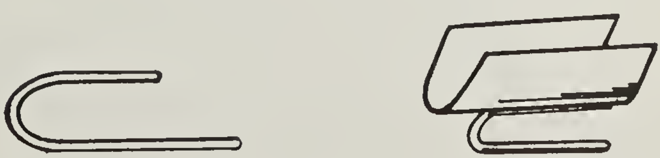
Launching a Glider

Once your plane is properly trimmed, you can take it out to the field to fly it from a high-start. You will need another person to help you with your high-start, which is similar to getting a kite into the air. A sturdy fishing line of 50 yards (50 meters), a metal ring and a small flag are all you need. (It is also nice to have a small fishing reel to hold the line when you are finished with it.) Your basic high-start gear will look something like that in Illus. 27.

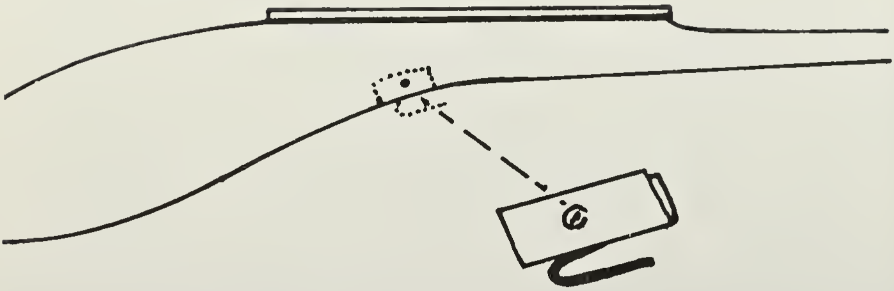


Illus. 27. The basic high-start gear.

First, attach the ring to the start hook which is fastened to the underbelly of the plane beneath the wing. (To install a start hook on your glider, take a small piece of piano wire ($\frac{1}{24}$ inch—.8 to 1.0 mm.—in diameter for a small plane, $\frac{1}{16}$ inch—1.5 to 2.0 mm.—in diameter for larger models) and bend it to the shape shown in Illus. 28. Then make a U-shaped piece of light metal and solder the hook to it, as in Illus. 28. Now you can



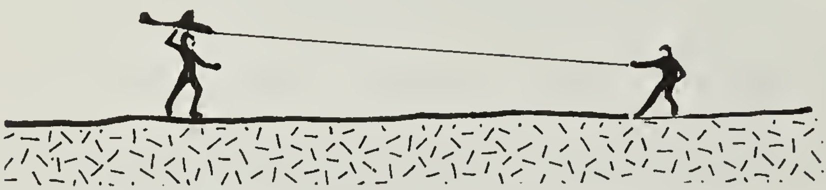
Illus. 28. Make your start hook with a small piece of piano wire, then bend and solder it to light metal (right).



Illus. 29. Attach the start-hook assembly to the underside of the fuselage with screws or a pin.

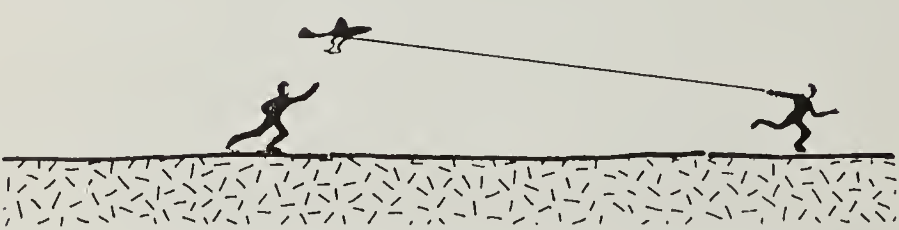
fasten the assembled hook arrangement to the fuselage with small screws or a metal pin, as shown in Illus. 29.)

Now have your friend walk away from you with the model while you let out line from the reel (see Illus. 30). When the line is fully extended, your helper holds the model well above his head and you both make ready for the start. At a signal, start

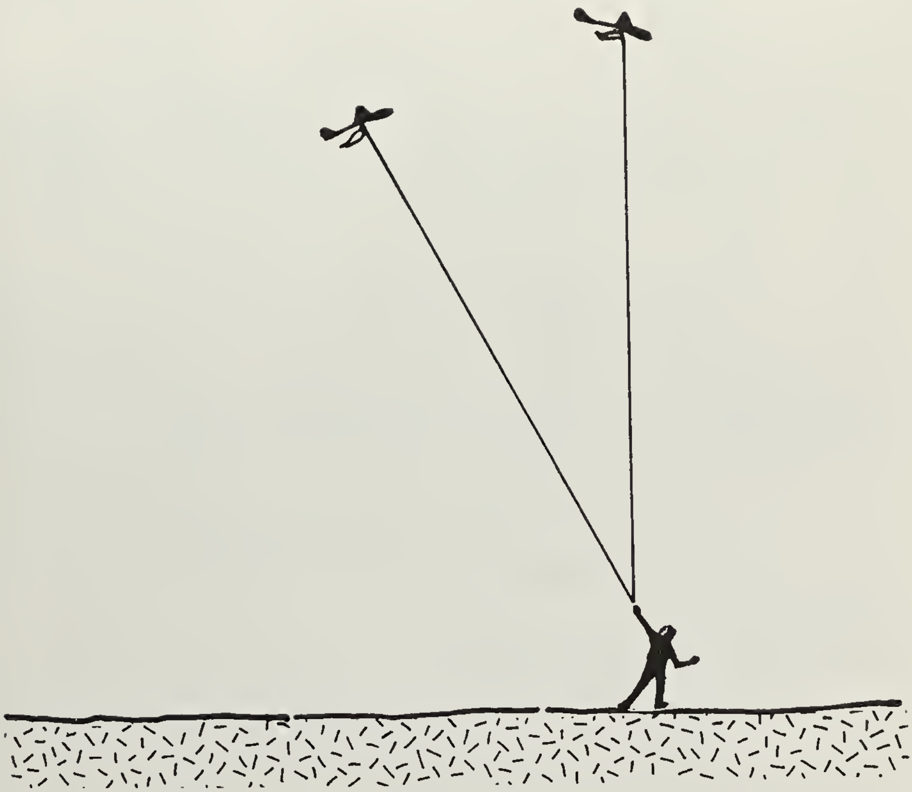


Illus. 30. Ready for the launch, with the model's nose headed into the wind.

your run into the wind (Illus. 31). It is important that your helper also makes a short run for your model to get a proper lift-off.

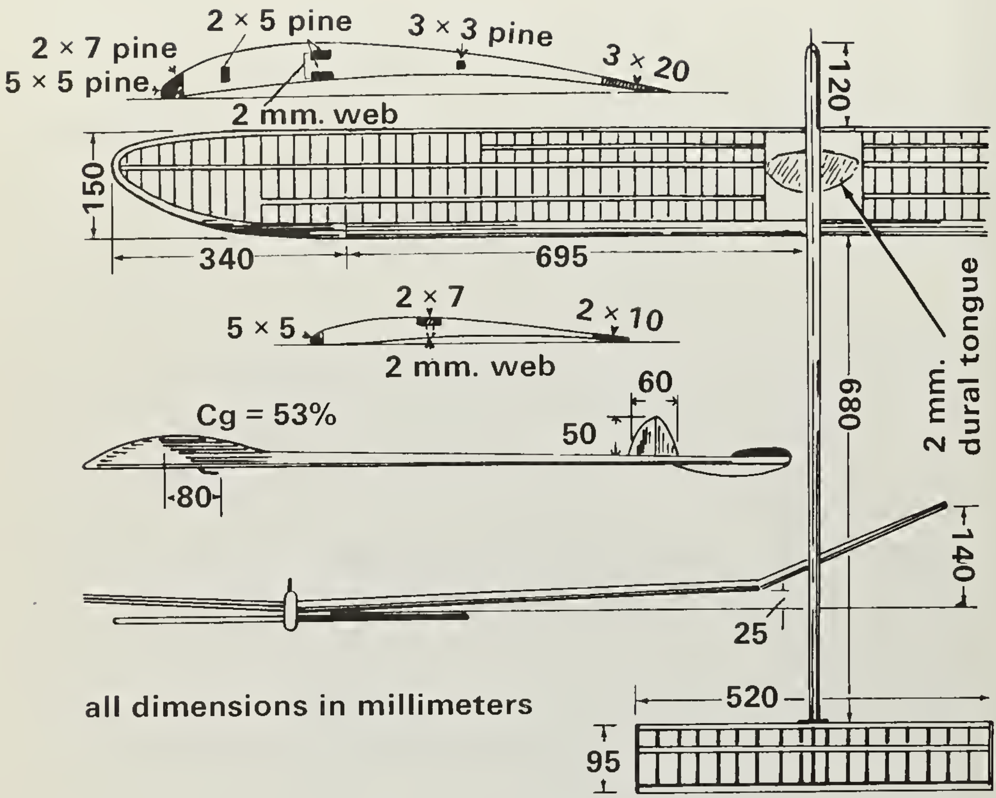


Illus. 31. At the beginning of your run, your helper should also make a short run to aid in the lift-off.



Illus. 32. When the model reaches its peak height, slow to a halt so that the line disengages.

The model will rapidly gain height and you must watch how it behaves by looking back over your shoulder. As it approaches the maximum height allowed by the start-line (in this case, 50 yards or meters), gradually slow your run until you come to a complete halt (Illus. 32). As you near the disengagement point and stop your run, the tension on the towline is decreased, and the pressure of the air will blow the towline off the hook. The flag fastened to the towline provides wind resistance to assist the disengagement.



Illus. 33. You can build a Nordic glider from these plans if you have some experience with building and flying kit models.

THE NORDIC GLIDER

A Nordic type, like the plane in Illus. 33, is the classic free-flight glider. It is recognized all over the world as a high-performance competition plane. Originally created in Scandinavia (hence the name), the Nordic glider has gone through a long development period. It is known for the high quality of its aerodynamic performance. The table below shows some typical features of Nordic planes, based on the two main Nordic models—the "all-weather glider" and the typical "thermal glider." Both models correspond to the basic Nordic formula, but they exhibit some significant differences. The thermal glider is only flown in good, calm conditions. The all-weather glider can be flown in windy, rather rough conditions when the air is more turbulent than usual.

	Thermal Type	*All-Weather Type*
Wing area	465–542 sq. in. (30–30.5 dm^2)	442–457 sq. in. (28.5–29.5 dm^2)
Aspect ratio of wing	12–15	10–13
Dihedral of wing	12–15°	8–10°
Thickness of wing	5–6%	6–8%
Maximum curvature of wing section	40–50%	35–40%
Nose radius of wing section	0.8	0.6–0.7
Tail area	52.7–62 sq. in. (3.4–4 dm^2)	62–82 sq. in. (4–5.5 dm^2)
Aspect ratio of tailplane	6–7	5–6
Dihedral of tailplane	0–5°	5–10°
Thickness of tailplane	6%	6%
Maximum curvature of tailplane section	40%	40%
Moment arm	4–5 chords	3.5–4 chords
Length of nose	1–1.5 chord	0.9–1.5 chord
Start hook position	Just in front of center of gravity	15–20° in front of center of gravity

You must be an experienced model builder before you attempt to build and fly a Nordic free-flight glider. It demands the utmost care during the building, trimming and flying stages.

The aerodynamic layout must conform exactly to the plans if you are to obtain a glider that performs to your satisfaction. Be sure to read as much of the specialist information in the hobby magazines as possible before trying to design and build a Nordic of your own.

Free-Flying Power Models

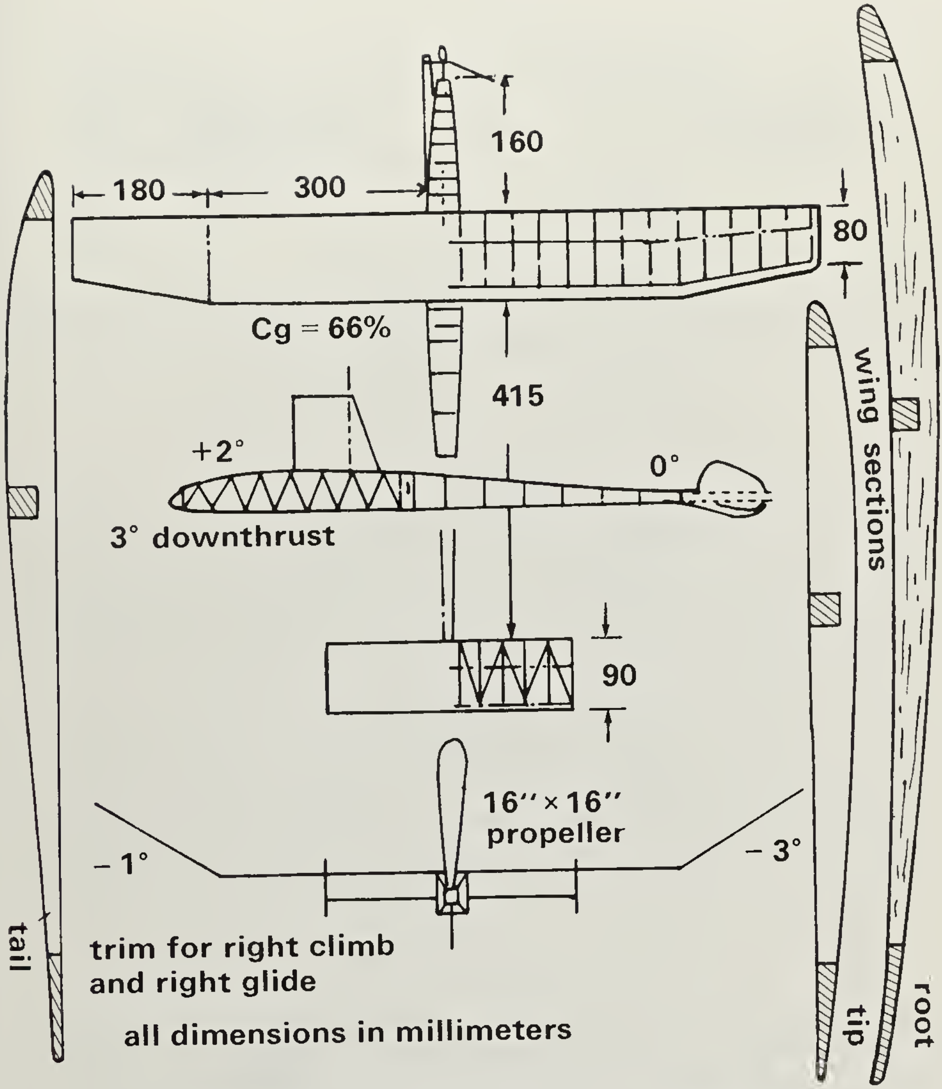
Five major types of motors are available for powered flight: rubber motors, glowplug motors, diesel motors, jet motors, and rocket motors. The first three types are commonly used in model flying. The glowplug motor holds first place over diesel engines as far as fuel-fed motors are concerned. Both the diesel and glowplug motors are technical jewels of unbelievable quality and performance.

Powered planes have many features in common with gliders as far as building and trimming are concerned. In general, a power model is heavier than a comparably sized glider, because of the motor, tank, landing gear, and the heavier, stronger framework required for the plane to cope with the stresses brought about by the increased speed. Because of the motor, you pay more attention to the distribution of weight and the strength of your model.

Powered planes are generally classified as sport or competition models. Each of these is broken down into various classes with specific rules for competition. The most famous is the Wakefield class, a type of rubber-powered model built to FAI (*Fédération Aéronautique Internationale*) specifications and flown in the classic event for Lord Wakefield's Trophy.

Another special type is the Coupe d'Hiver model (Illus. 34). This plane is also built according to special formulae and flown worldwide in Coupe d'Hiver competitions. Both Coupe d'Hiver and Wakefield models are highly technical projects for experts. Beginners will do well to start off with simpler projects.

A newcomer's first project should be either a simple stick model, or an equally simple cabin model. The temptation, of course, is to start in immediately with a fancy scale biplane,



Illus. 34. The Coupe d'Hiver class of planes is built to exacting standards and flown by special competition rules. These are highly technical and are a challenge for the expert modeller.

Illus. 35. A biplane (left), while tempting, should be avoided by a beginner. Instead, start with a simple cabin model of sturdy design (right).

like the one in Illus. 35. While it is smart looking, it will give you nothing but headaches. If you feel you still want to try a scale model, at least go for a *simple* scale model. The high-wing design in Illus. 35 is a good choice. Even better would be a model like the functional cabin design in Illus. 36.

For any free-flying model, you must take extra care in the selection of building materials. You must be careful with the weight of the balsa wood, which can vary considerably and give you a completely different wing loading than you originally planned.

Illus. 36. This functional cabin design will give the beginning modeller a stable ride.

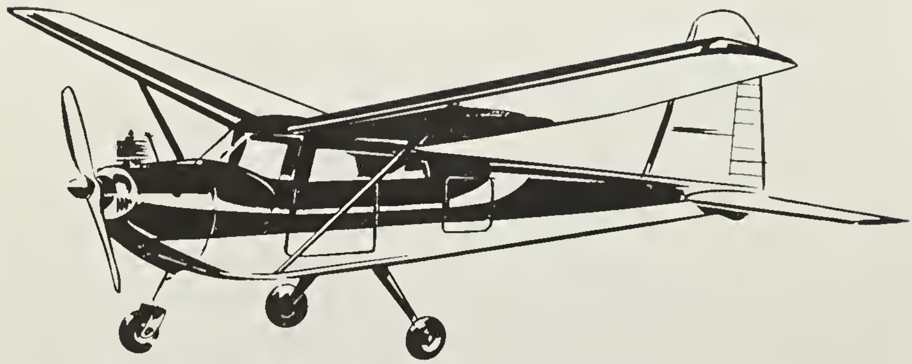
You can use the following table as a reference guide when you begin to actually build planes from scratch.

Density in Pounds per Cubic Foot	*Grade of Balsa*	*Application*
6 and below	Ultra-light	Indoor display models and wing tips on larger, flying models
6 to 8	Light	Sheet fill-in on fuselage, sheet covering on wings, and cowlings
8 to 9	Light to medium	Same as light balsa for slightly heavier models
9 to 10	Medium-light	Spacers on box fuselage, trailing edges, and ailerons
10 to 12	Medium-hard	Wing spars, trailing edges, carved propellers
14 to 15	Hard	Main wing spars, leading edges, bulkheads
16 and over	Extra-hard	Same as hard balsa with some weight penalty

Remember always to try to fit your material to the project. Hard balsa is by no means best suited to all models or for all purposes. With experience, you will learn how to balance the strength and weight factors in your models.

RUBBER-POWERED PLANES

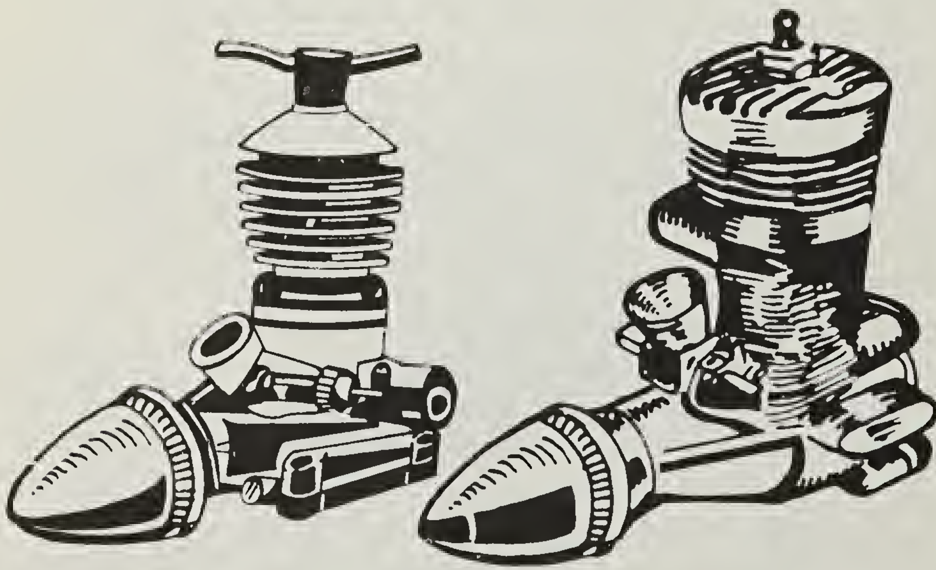
Rubber-powered models are popular with all age groups, mainly because they are fairly simple to operate. Rubber-powered craft give you the maximum flying time per work-hour at the building board, but you are restricted to specific weights, sizes, and types of planes. These restrictions are probably the main reason for the popularity of glowplug and diesel motors. Turn back to page 40 for details on how to build and trim your own rubber-powered engine.



Illus. 37. The sturdy high-wing design of this model will go well with a diesel or glowplug motor.

DIESEL OR GLOWPLUG ENGINES

If you decide to begin your model-flying career with a diesel- or glowplug-powered plane, look first at the remarks beginning on page 42. Try to build a functional cabin model like the plane in Illus. 37. The general specifications are a wingspan of 36 to 48 inches (90 to 120 cm.) powered by a .048 to .15 cu. in. (.8 to 2.5 cc.) engine. Illus. 38 and 39 show a popular diesel engine



Illus. 38 (left). Piccolo is a popular diesel engine. Illus. 39 (right). This glowplug engine can turn at a rate of up to 15,000 r.p.m.

and a glowplug engine that are widely used. These small motors can turn at a rate of up to 15,000 or 20,000 r.p.m. (revolutions per minute). They can deliver thrust in the region of 0.1 to 0.6 horsepower. The following table will help you determine a theoretical tip speed for particular engine and propeller combinations.

TIP SPEED—M.P.H.

r.p.m.	*Propeller Diameter—inches*						
	6	*7*	*8*	*9*	*10*	*11*	*12*
6,000	107.1	124.9	124.8	160.6	178.5	196.4	214.2
8,000	142.8	166.5	190.4	214.1	238.0	261.9	285.6
10,000	178.5	208.1	238.0	267.6	297.5	327.4	357.0
12,000	214.2	249.8	285.6	321.2	357.0	392.8	424.4
14,000	249.9	291.4	333.2	374.7	416.5	458.3	495.8
16,000	285.6	333.0	380.8	428.2	476.0	523.8	571.2
18,000	321.3	374.7	428.4	481.8	535.5	589.4	642.6
20,000	357.0	416.0	476.0	535.2	595.0	654.8	714.0

If you couple a 20,000 r.p.m. engine with an 11- or 12-inch propeller, you will see that you are no longer playing with a child's toy. You are rapidly approaching the sound barrier!

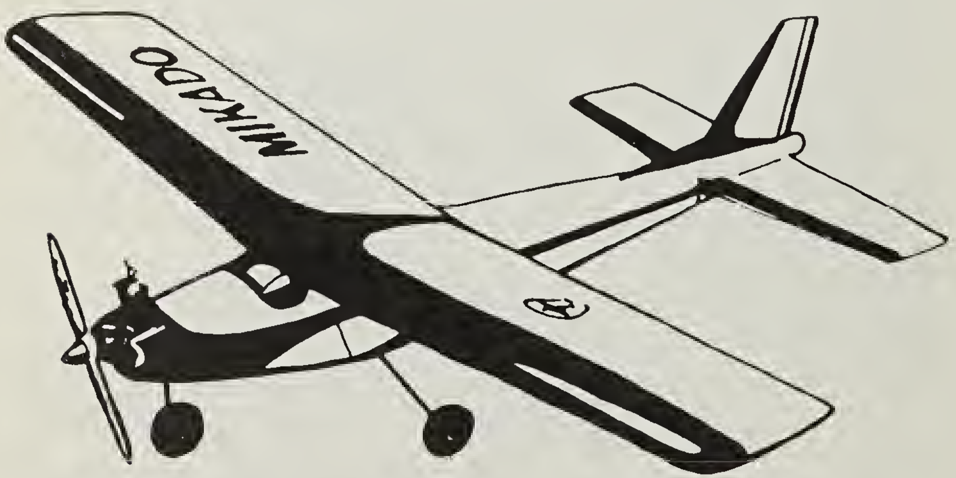
The chart below lists different sizes of diesel and glowplug motors and the propellers best suited to use their power in the most efficient way. Because diesel and glowplug engines run at different speeds, they take different size propellers for maximum thrust. Glowplug engines generally turn out a much higher r.p.m. than diesel engines. You compensate for this with a different-size propeller. The following are suggested motor-propeller pairings:

Motor type/size	*Propeller size*
.048 cu. in. (.8 cc.) diesel	6×3″ to 7×4″
.06 cu. in. (1.0 cc.) diesel	6×4″ to 8×4″
.09 cu. in. (1.5 cc.) diesel	7×4″ to 8×4″
.15 cu. in. (2.5 cc.) diesel	8×4″ to 9×4″
.21 cu. in. (3.5 cc.) diesel	9×4″ to 10×4″

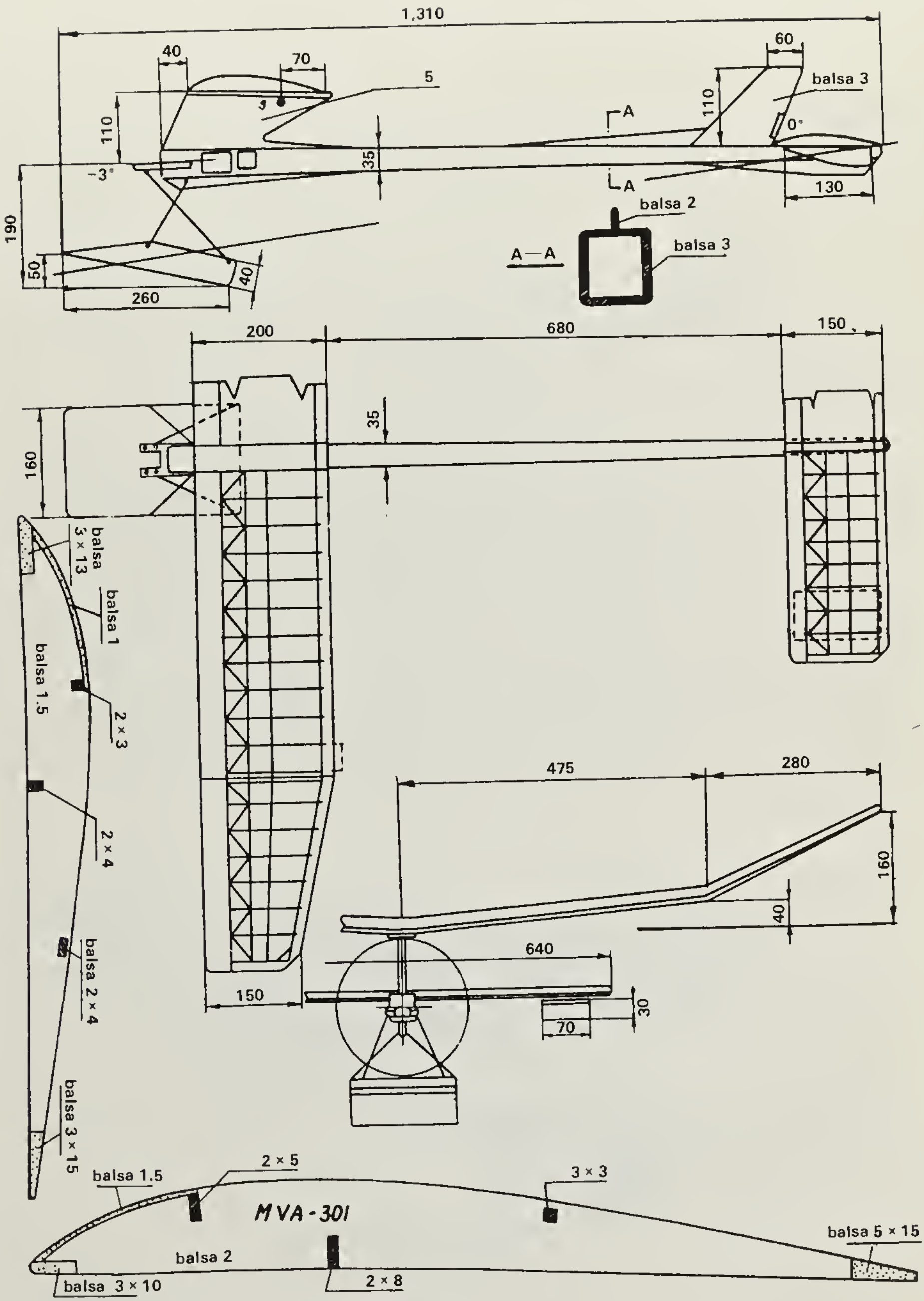
Motor type/size	*Propeller size*
.048 cu. in. (.8 cc.) glowplug	5×3″ to 6×4″
.09 cu. in. (1.5 cc.) glowplug	6×4″ to 8×4″
.15 cu. in. (2.5 cc.) glowplug	7×4″ to 9×4″
.21 cu. in. (3.5 cc.) glowplug	9×4″ to 9×6″
.30 cu. in. (5.0 cc.) glowplug	9×6″ to 10×6″
.36 cu. in. (6.0 cc.) glowplug	10×4″ to 11×6″
.48 cu. in. (8.0 cc.) glowplug	11×4″ to 12×4″
.60 cu. in. (10.0 cc.) glowplug	11×8″ to 12×6″

The most popular diesel or glowplug frameworks are the sports types, like the cabin trainer shown in Illus. 37 on page 66. Another popular model is the somewhat heavier plane shown in Illus. 40. This plane makes a very good trainer for both free-flight and radio-controlled operation.

If competition is your thing, you should try your hand at a competition model, like the one shown in Illus. 41. Equipped with a .15 cu. in. (2.5 cc.) motor, this plane is engineered for just a few seconds of powered flight followed by a calculated glide period. These "hot" competition models require very skilful building and very careful trimming.

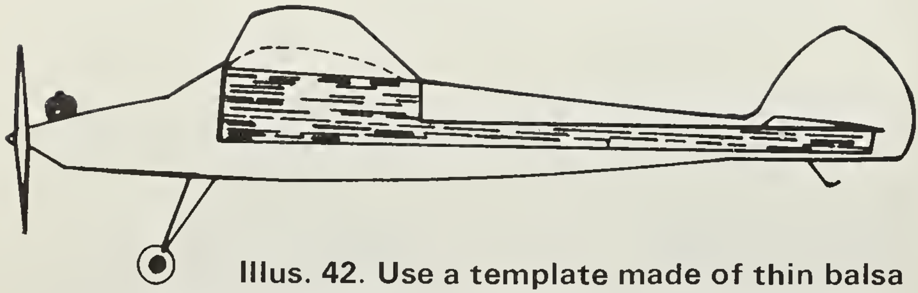


Illus. 40. Mikado is a heavier model that makes a good free-flight or radio-controlled trainer.



all dimensions in millimeters

Illus. 41. When you have some experience, you can build a competition model similar to this one. It is engineered for a short power climb followed by a slow, graceful descent to the ground.



Illus. 42. Use a template made of thin balsa sheet to check the accuracy of the wing setting.

BUILDING AND TRIMMING A POWERED MODEL

The build-up for a power plane is similar to that for a glider, but you must be more careful in your selection of materials so that you get the most favorable weight-to-strength ratio.

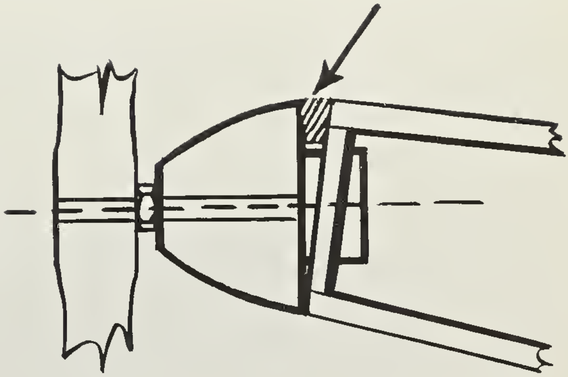
The balancing and trimming procedure for a powered plane is the same as for a glider (see page 54). You should also use a template to check the accuracy of the wing setting on both sides. Make this template out of $\frac{1}{8}$-inch (3-mm.) balsa sheet and place it under the wing and tailplane (Illus. 42). Be sure that when you cut the template you allow for the correct angle of incidence.

THE FIRST FLIGHTS

The first few flights after your trimming procedure is finished must be made with minimal power and neutral rudder. Increase

Illus. 43. Start your trimming flights with a hefty hand launch. You want to achieve a flight like the ideal path A in Illus. 25.

Illus. 44. Correct the thrust line by packing slivers of balsa behind the propeller.



the power gradually and watch how your plane behaves. Any excessive left-turning tendency (due to the torque created by the propeller) must be corrected by moving the engine so its thrust line is slightly down and to the right. (You need a slight left-turning tendency.) Keep the fuel very low on the first trim flights or, if you have a timer, set it to cut off after 4 to 5 seconds. You want to get your model to climb steeply with a slow leftward turn in the power stage, and then shift to a nice

Illus. 45. The starting position for a vertical take-off.

circular glide after the engine cuts off. (The propeller will naturally produce some drag during the glide portion of the flight, but this is something you just have to accept. It will be of minor effect, in any case.)

Once this is done, you are ready for your final check flights and first real powered free-flight.

In competition, you will always begin with a vertical starting position. This is called vertical take-off or V.T.O. and produces a more breath-taking version of your trimming flights.

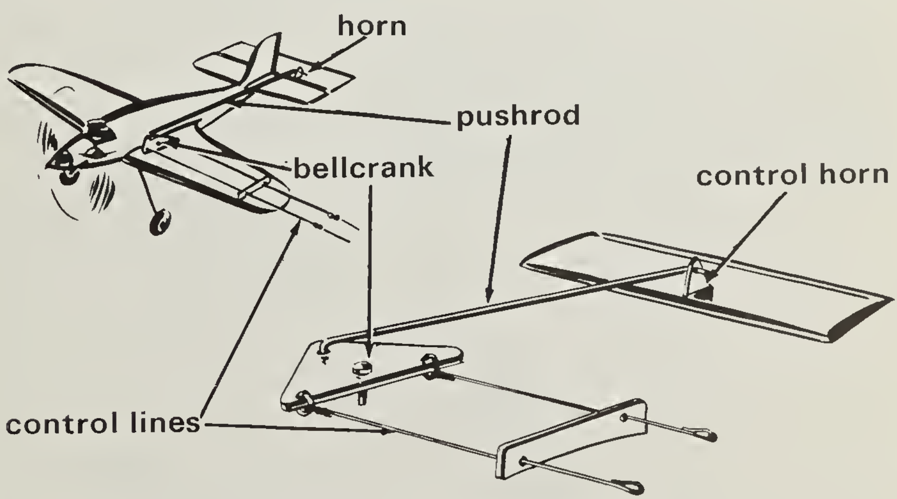
Line-Controlled Models

Line-controlled model planes first appeared in the early 1940's. Since then, this aspect of model airplane flying has gained widespread popularity. Line-controlled models are so popular because they are one of the best ways to fly in areas where large flying fields are scarce. Any recreation ground or sports field will do.

As the term "line-controlled" indicates, the model is held and guided by the pilot using two lines which run from a handle which he holds to a simple steering mechanism in the plane. This mechanism, in turn, controls the movement of the elevator. You can install additional, more complicated mechanisms which will give you control of the flaps and the throttle as well. These advanced controls, however, are best left to expert pilots.

Basic Flying Technique

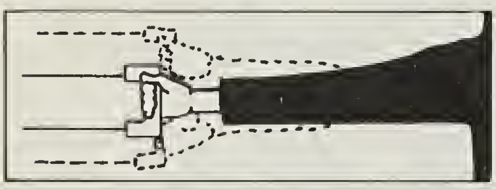
The simple elevator control system is shown in Illus. 46. The control lines run through a wire guide on the left wing to a

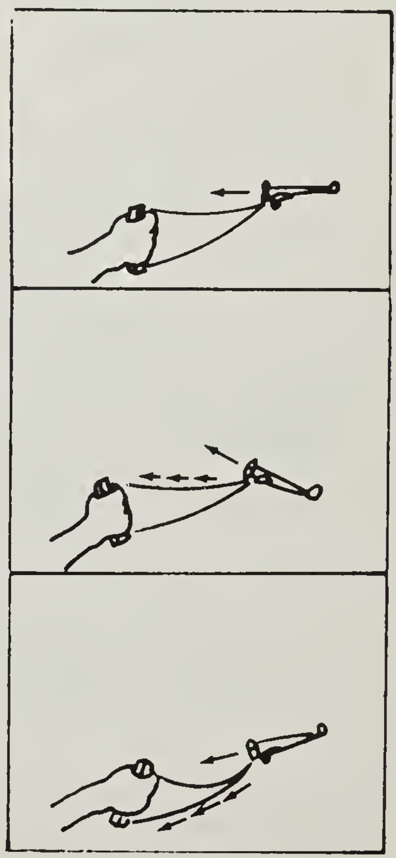


Illus. 46. A simple line-controlled system.

bellcrank. This bellcrank is connected in turn by a stiff pushrod to a control horn which is mounted vertically on the elevator. The elevator can move up or down on the hinges that connect it to the tailplane. When the pilot moves the control lines, the bellcrank turns on its pin, the stiff pushrod moves forwards or backward, causing the elevator to go up or down, thus controlling the path of the plane in the air.

The control handle and the position of the pilot's steering arm are important to the control of the plane. The pilot should keep the control handle in his best steering hand, and his steering arm should always point away from his body, straight at the plane. When flying, any movement up or down with the straight arm causes a simple up or down movement of the plane. Twisting the control handle initiates the more complicated transfer through the control lines to the elevator, which also causes an up or down movement of the plane along its circular flight path.

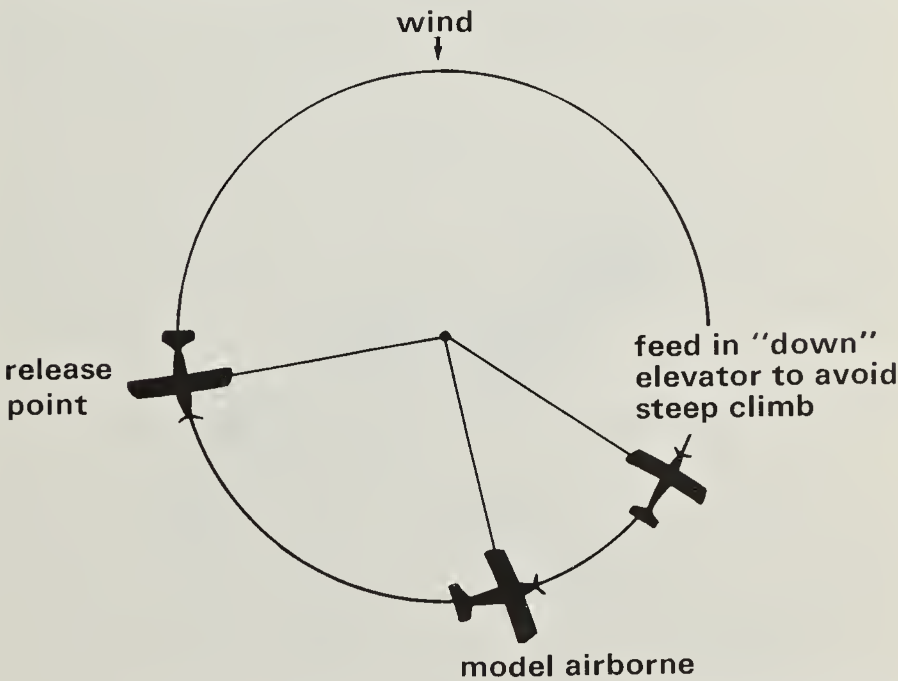




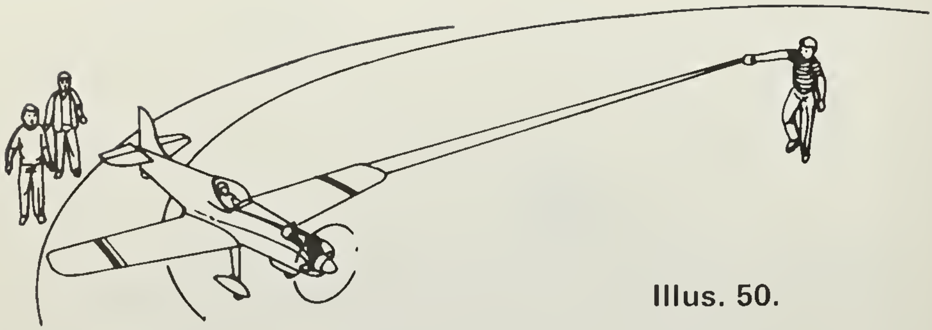
Illus. 47. (Above). Simple up-and-down arm movements control the movement of the plane. (Right). A more complicated control is exercised by the use of the control handle.

Illus. 48. A pilot and his "crew" ready for take-off.

The take-off technique for a line-controlled model varies with the weight and power of the plane. A lightly loaded plane with a strong motor will take off easily with just a little "up" elevator. A heavy model with a less powerful motor requires a lengthy take-off run before it will obey the up-elevator command. Illus. 49 shows the basic take-off pattern. You begin the run with the wind at the airplane's tail. Your model should lift into the air at about the point where you turn into the wind. When it is fully airborne and flying directly into the wind, feed in a little down-elevator in order to avoid too steep a climb.



Illus. 49. The take-off procedure for a line-controlled plane.



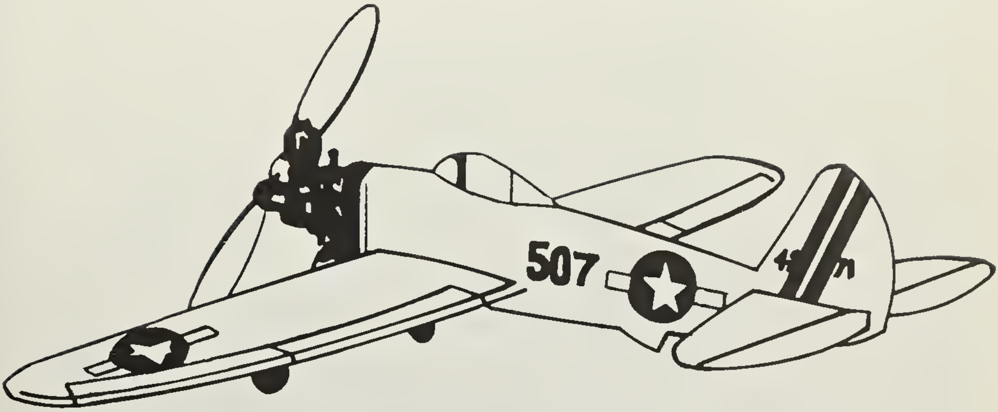
Illus. 50.

Once your plane has reached cruising altitude, concentrate on flying a simple, relaxed circular pattern. Try to keep your plane on a level flight, using very small corrections from the control handle. Don't fly too long on these first flights—30 to 50 seconds will be enough—so don't squeeze in too much fuel. Let the plane fly around you until the motor stops. Then let it glide to land as softly as possible, carefully raising your arm a little to produce some "up" elevator effect.

Newcomers to line-controlled aircraft often overcontrol their planes. Experience will teach you just how much "touch" you need. Always remember to keep your arm straight and pointing towards the model while it is in flight (Illus. 47). With practice, you will learn to experiment with this basic flying technique. Expert pilots have different ways of holding the control handle, and use different steering arm positions. Once again, the best advice for beginners is to keep everything simple at the start.

The Beginning Model

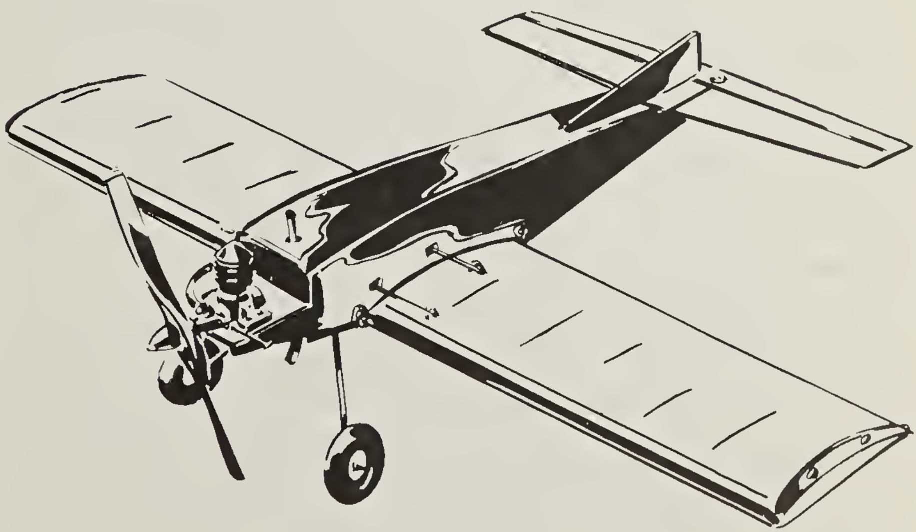
You will be well off if you choose a simple kit for your first line-controlled airplane. Ask at your hobby shop for specific recommendations. Try to begin with a functional, durable model that looks something like the planes shown in Illus. 51 and 52. The Thunderbolt in Illus. 51 is one of the best projects for raw novices of all ages. Manufacturers know this and the hobby market is flooded with "profile" models of this sort. The model in Illus. 52 requires a more complicated building routine,



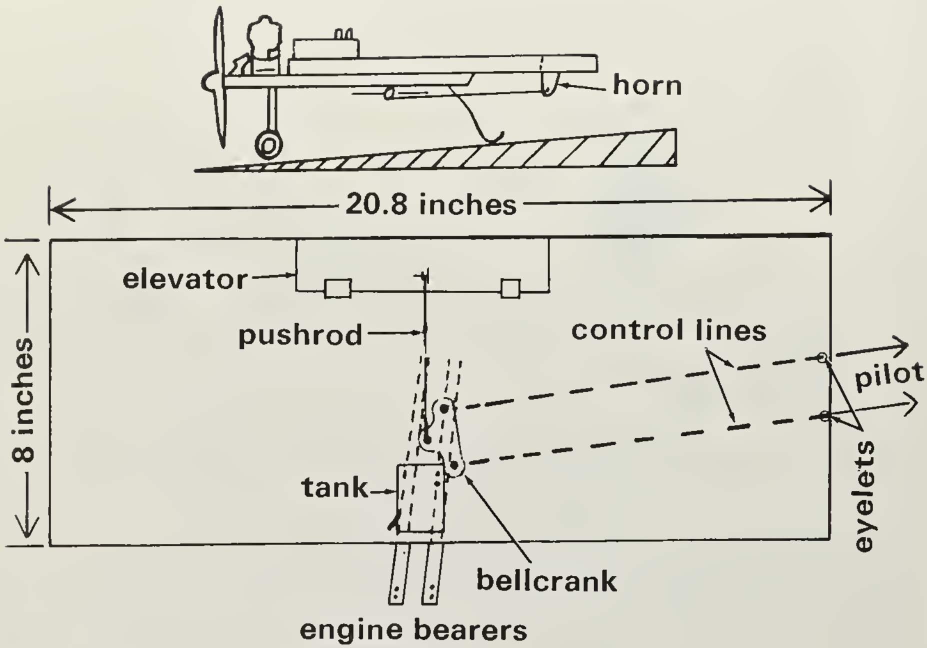
Illus. 51. This profile model is suitable for beginners.

so models like it might better be left for your second time at the building board.

For experienced pilots and real experts, there is a broad selection of sophisticated models in different competition classes—stunters for acrobatic flying, team racers for the popular team-racing event, speed models and scale models. Each of these groups has its own specific competition rules and specifications.



Illus. 52. The fuselage in this model can be hollowed out of solid balsa or can be built up from sheet balsa.



Illus. 53. The Flying Door.

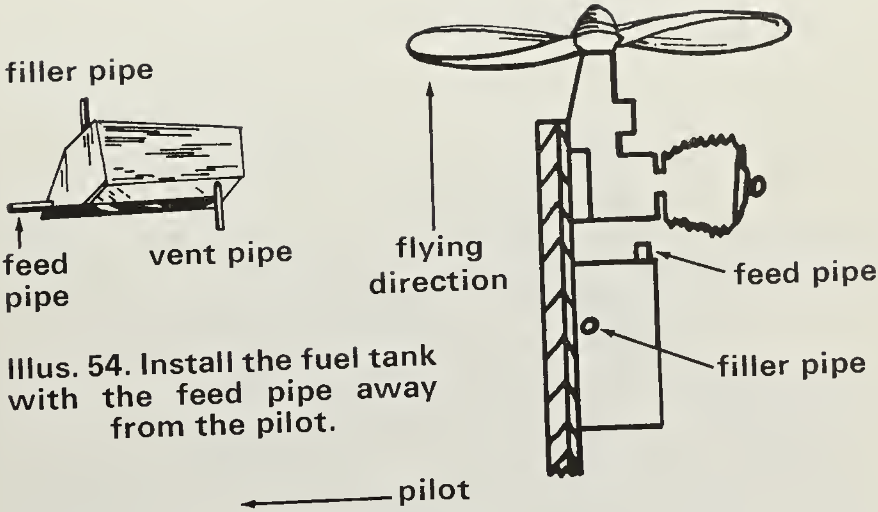
THE FLYING DOOR

Here is a simple line-controlled model that any beginner can build in just a few hours. You make the "wing" from fairly hard balsa. Use a couple of sheets .4 inches (10 mm.) thick, and make the wing to the dimensions shown in Illus. 53.

Cut engine bearers from .4 × .4 inch (10 × 10 mm.) hardwood and glue them carefully to the wing. Be sure that you position the engine bearers so that you get the correct right thrust from the engine, as shown in the diagram. Mount a good .15 cu. in. (2.5 cc.) engine on the bearers. Use epoxy glue to cement the fuel tank behind the engine.

Screw the bellcrank to the left engine bearer, making certain that it can rotate freely. Now, make a pushrod from .08 inch (2 mm.) piano wire and run it from the bellcrank to the elevator horn. Run the control wires from the bellcrank through two eyelets that you have screwed into the underside of the wing to your control handle. The lines are raked backwards as indicated.

This simple plane should balance on a point 2 to 2½ inches (5 to 6 cm.) back from the leading edge of the wing.



Illus. 54. Install the fuel tank with the feed pipe away from the pilot.

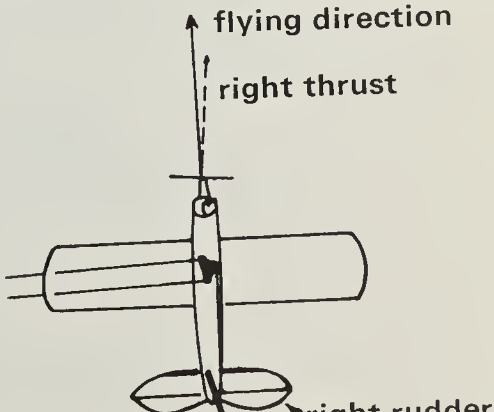
Building and Trimming

As with all model airplanes, the building and trimming of the model are of the utmost importance. Basically, the build-up of a line-controlled model is the same as that of other model airplanes. Since a line-controlled model will always fly in a circular pattern around the pilot, however, there are specific factors to keep in mind:

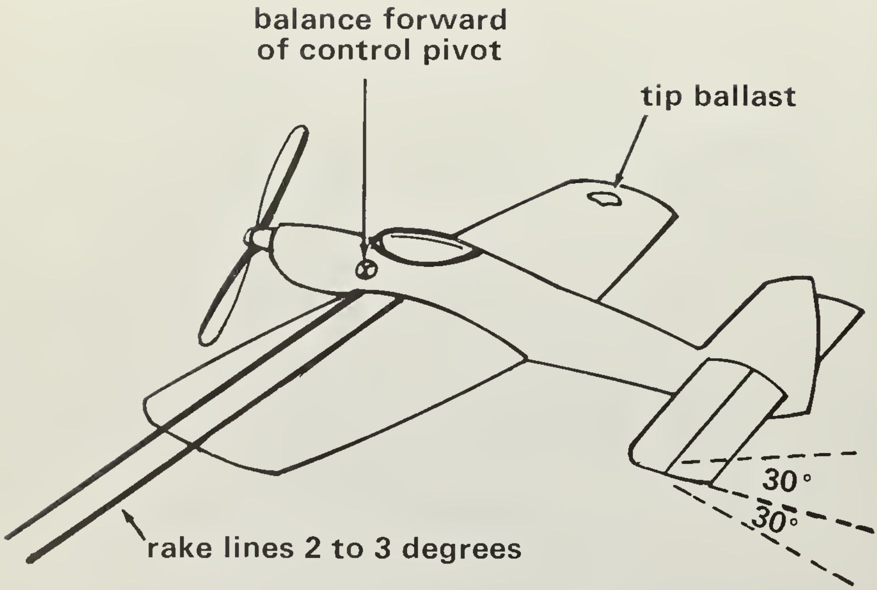
(a) Keep the control lines taut during flight to maintain control of your plane.

(b) Mount the fuel tank so that fuel can feed the motor when the plane is flying in any position.

(c) Because of the circular flight path, all fuel tanks must be mounted with the feed-pipe away from the pilot (see Illus. 54).



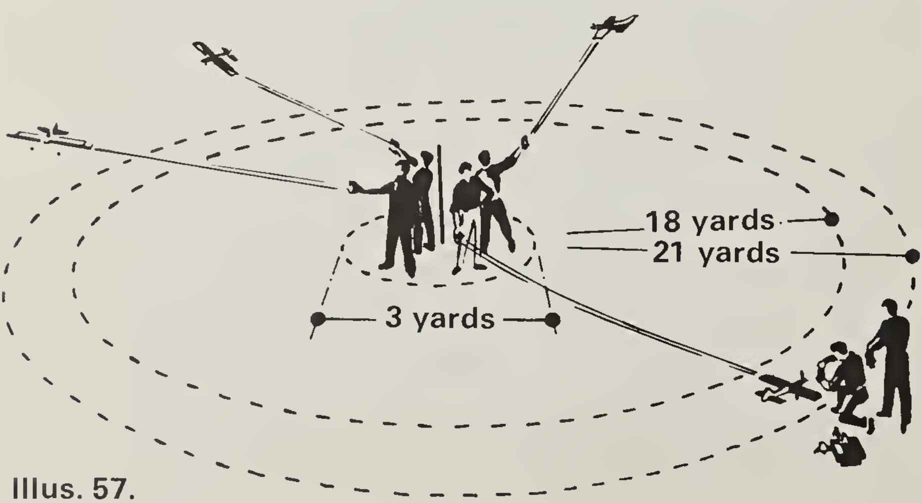
Illus. 55. Offset the rudder and motor to deliver considerable side-thrust.



Illus. 56. Some special accommodations you must make on any line-controlled model.

To keep the control lines stretched during flight, you must offset the rudder and mount the motor so that it delivers considerable side-thrust (Illus. 55). As all line-control flying is done counter-clockwise, the rudder must have a definite right deflection, and the motor must deliver a right thrust.

Other general rules need to be followed with line-control planes. The center of gravity of the plane should be forward of



Illus. 57.

the control pivot (where the bellcrank is anchored). You should place ballast at the tip of the right wing to compensate for the weight of the control lines. Limit the elevator movement to a maximum of 30 degrees deflection up or down. Finally, you can rake the control lines two or three degrees to the rear to keep them taut.

For line-controlled training planes the following general proportions should be used to determine the proper engine size in relation to a plane's weight and wingspan.

Motor	.06 to .09 cu. in. (1.0 to 1.5 cc.)	.15 to .21 cu. in. (2.5 to 3.5 cc.)	.21 to .36 cu. in. (3.5 to 6.0 cc.)
Wingspan	24 in. (60 cm.)	30 in. (65 cm.)	36 in. (90 cm.)
Wing chord	5 in. (12.5 cm.)	6 in. (15 cm.)	7 in. (17.5 cm.)
Tail span	10 in. (25 cm.)	13 in. (32.5 cm.)	15 in. (37.5 cm.)
Tail chord	3 in. (7.5 cm.)	4 in. (10 cm.)	5 in. (12.5 cm.)
Overall length	16 in. (40 cm.)	20 in. (50 cm.)	24 in. (60 cm.)

For simple trainers and typical profile models, a flat-plate wing like the one used in the "Flying Door" is adequate and will do a good job. A more advanced wing, however, needs a wing section designed for the particular model. The three standard wing sections used in line-control flying are the Clark Y for trainers, the RAF 30 for stunt planes, and the NACA 0018 for large aerobatic planes. Very thin wing sections

Illus. 58.


Illus. 59.

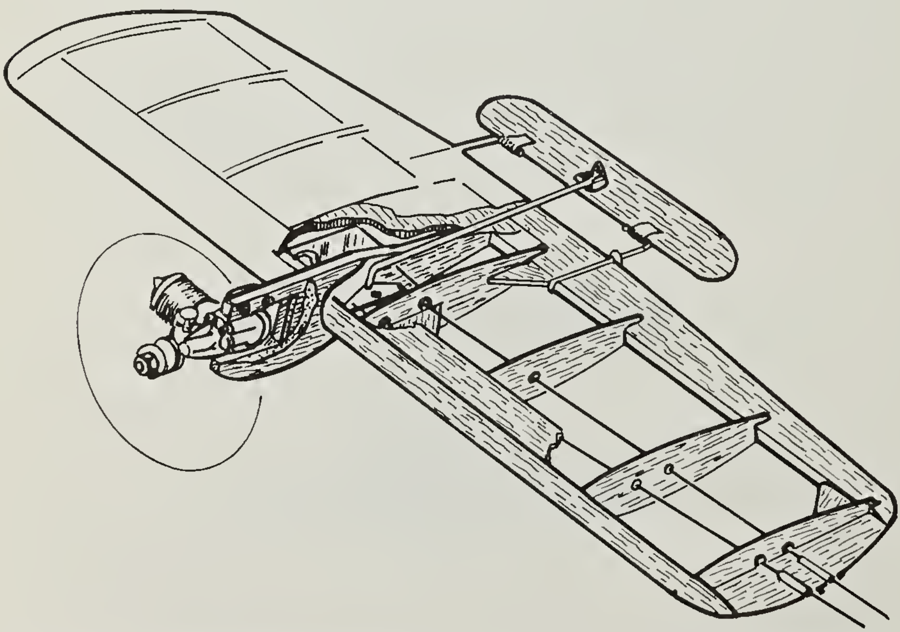

Illus. 60.


Illus. 61.

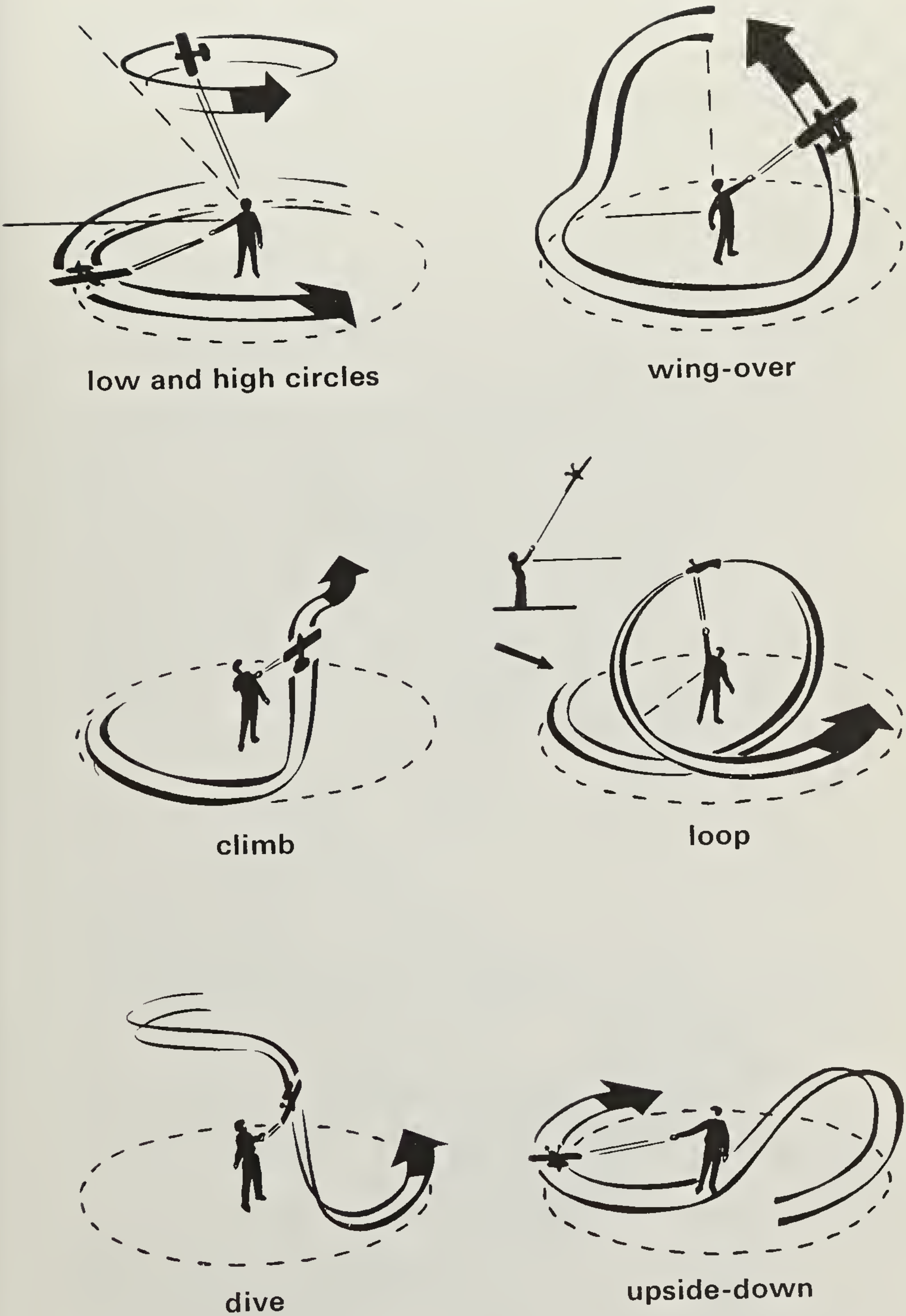
like the one in Illus. 61 are used for speed flying. Wings of this design usually have a fairly sharp leading edge. Until you are ready to design your own models, the wing provided in kits or specified in plans will do more than an adequate job for you.

The building of both the wing and tail follow fairly conventional procedures, but there are a few special considerations that you must be aware of. Make sure that the control lines can run freely. (This is especially important if you mount them internally through the wing.) All your other connections must also be easily operable, so that you will have control of the plane once it is in the air.

Cover and fuel-proof your model carefully. A considerable amount of fuel and exhaust floods over and around a model before and during flight. A careful job will give your plane a longer life.



Illus. 62. This simple combat plane can be constructed in an afternoon. Note the placement of the control lines within the wing structure.



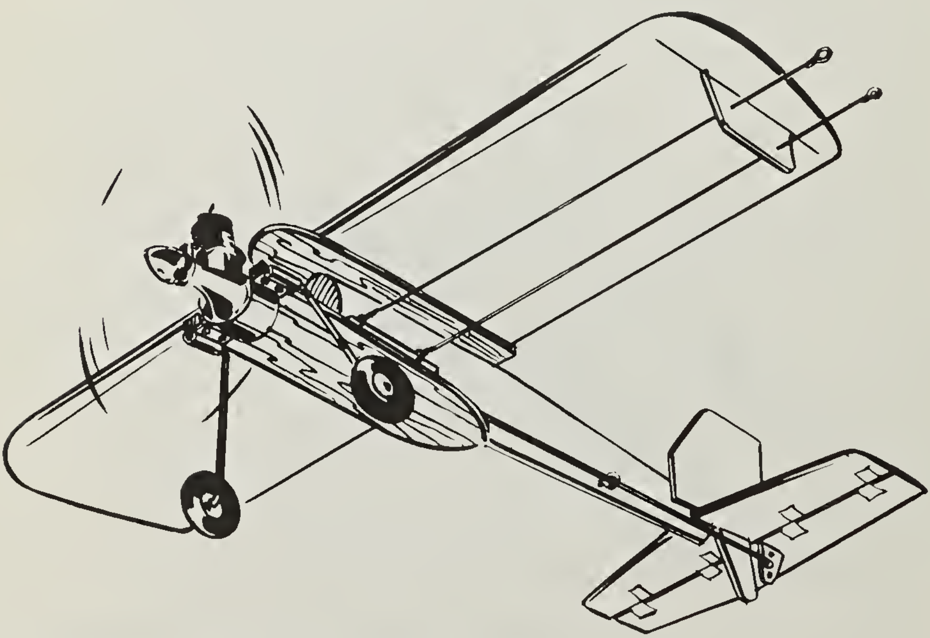
Illus. 63. Basic line-controlled manoeuvres.

Finally, you must match the length of the control lines to the size of your model's motor. The following guide provides rough values for determining the proper length.

Motor size	*Length of control lines*
.06–.09 cu. in. (1.0–1.5 cc.)	7–10 yards or meters
.10–.15 cu. in. (1.6–2.5 cc.)	9–11 yards or meters
.16–.30 cu. in. (2.6–5.0 cc.)	14–17 yards or meters
.31–.60 cu. in. (5.1–10.0 cc.)	15–22 yards or meters

The overlapping values allow for differences in the weights of various planes. Every kit and building plan tells you line length intended for that particular model.

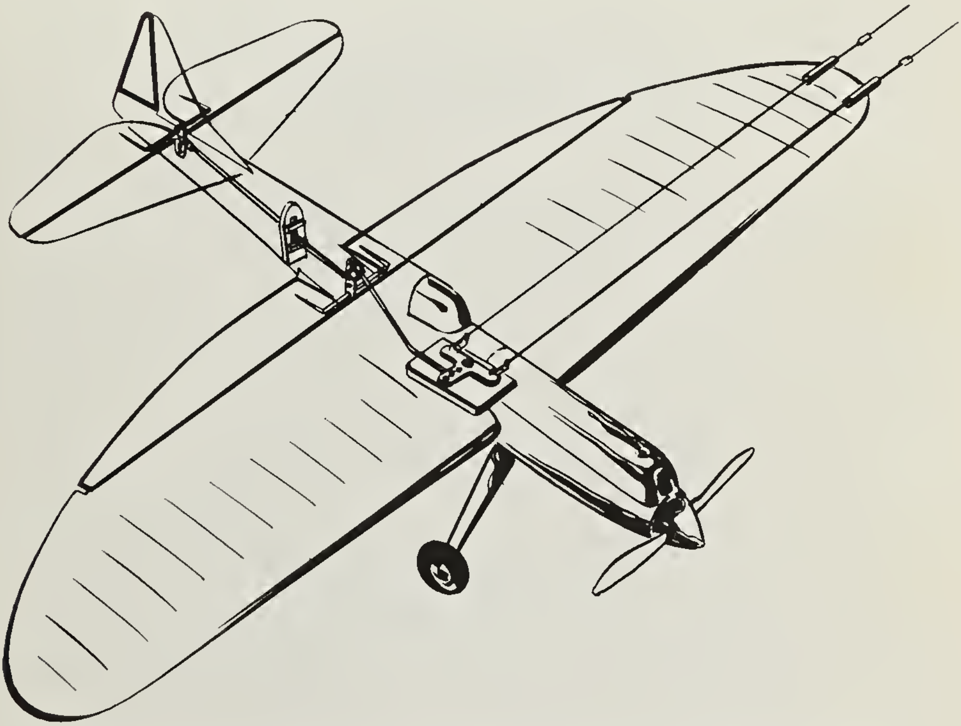
If you want to build a simple model of your own design, and you have some building experience behind you, try to draw up plans for the simple plane pictured in Illus. 64. This trainer is simple and fairly strong. You can design it so that the wing is easily detachable. This "ugly" looking trainer may even raise a new interest in basic line-control trainers in your area. The



Illus. 64. A line-controlled trainer.

simplicity of the design makes it an ideal project for a junior program.

Again, if you have some building and flying experience, and you want a lively model, the combat-style plane in Illus. 62 may interest you. Design a building plan from the sketch and you'll be ready to go.



Illus. 65. Flaps are connected to the elevator pushrod. When the elevator is raised, the flaps are lowered.

ADDITIONAL CONTROL FUNCTIONS

Control of the flaps and throttle offer interesting possibilities for the expert pilot, but should only be used if you have enough experience. These additional controls require more care and general maintenance for the model than most model pilots can or want to put into their planes.

Flaps are normally connected to the elevator pushrod as shown in Illus. 65. When the elevator is raised, the flaps are lowered, thus increasing the lift. In stunt flying, this produces the very quick response needed for fancy aerobatics.

Throttle control is achieved by using a third wire which runs parallel with the control lines into the model. This wire is then connected to a specially designed mechanism that controls the exhaust throttle. A slide runs through the exhaust port, which ultimately controls the speed of the engine and propeller.

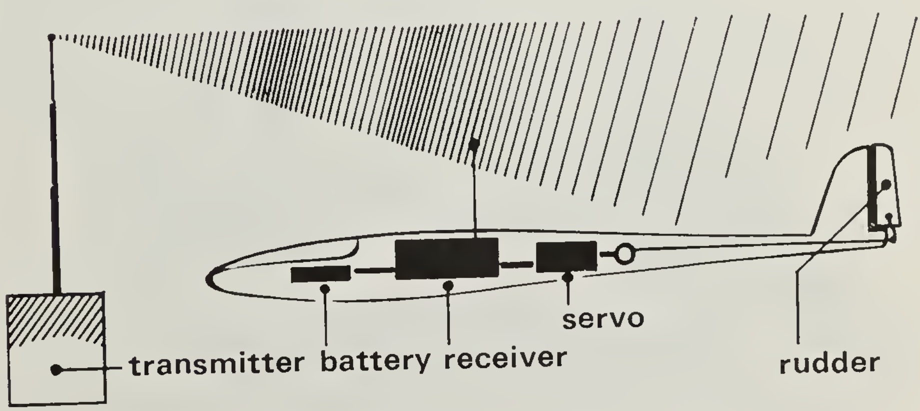
With the addition of flap and throttle control it is possible to simulate very impressive flight patterns of full-size aircraft. But, again, these controls should be used by experienced pilots only. If you cannot control your model plane, it can become a nuisance and possibly a dangerous weapon.

Radio-Controlled Model Airplanes

Modern radio systems were first developed 70 to 80 years ago. The rapid development and expansion in electronics that followed resulted in radio broadcasting, television, radar and guided-missile systems.

Radio-controlled flight is a rapidly growing branch of the model flying hobby. It is probably the fastest-growing sport within modern aviation and has a tremendous appeal to the wide range of people who have an interest in technical achievements. Naturally, because of the complexity and the money involved, this particular part of the model flying sport belongs primarily to adults, although it can also be valuable as a joint parent/child activity.

A radio-control system (usually referred to as an RC-system) consists of a hand-held transmitter and an airborne control unit. The pilot uses his transmitter to guide his model plane as if he were in the cockpit, taking it through a series of turns,



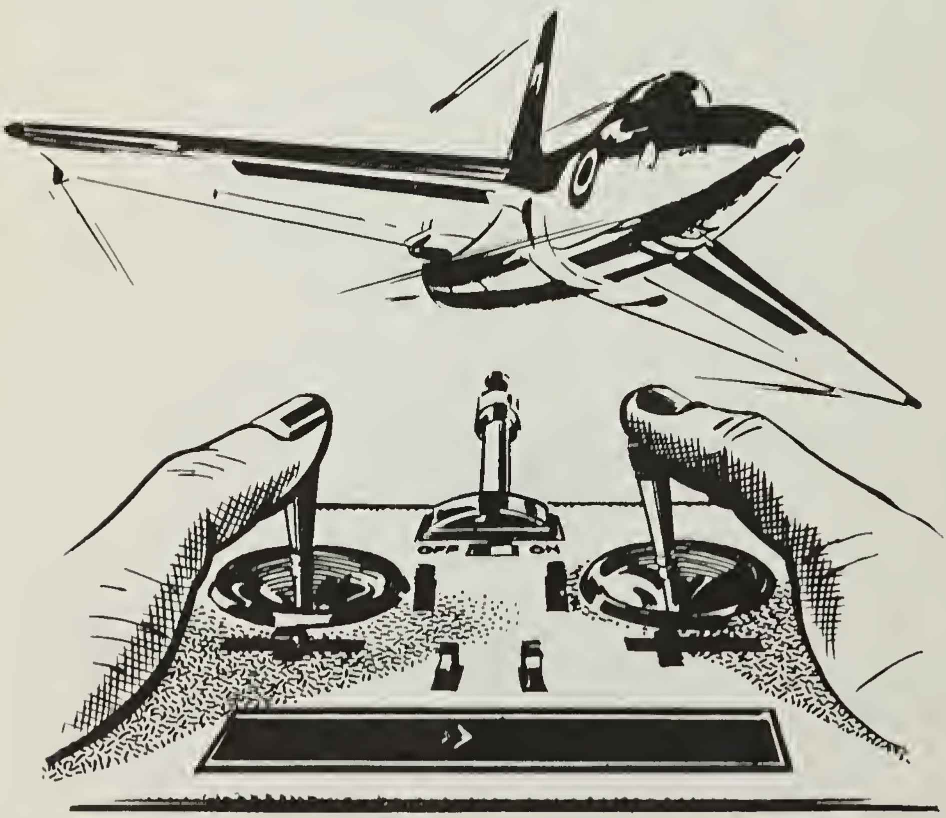
Illus. 66. A basic radio-control system.

rolls, loops and other manoeuvres. The only limit to such a show is the pilot's skill and his plane's capability.

There are two major divisions of radio-controlled airplanes: RC-sailplanes and RC-power models. These two categories are further divided into various sub-groups.

The simplest models are those equipped with rudder control only. These are intended primarily for the beginner. The basic control sequence for such a model is shown in Illus. 66.

From this simple model, there is quite a jump to the more sophisticated, powered machines that you can fly. It is possible to put together a detailed scale model with radio-controlled throttle, rudder, flaps—even steerable landing gear with brakes. A modern RC-plane is nothing less than a miniature plane with the pilot standing on the ground. Using his control gear, he can put his plane through brilliant manoeuvres without the risk of blackouts. RC-flying is a modern sport made possible by the intelligent use of electronics, mechanics and aerodynamics.



Illus. 67.

Radio-Controlled Sailplanes

Perhaps at some time you have seen a full-size sailplane in action—big, slender, silent and graceful. Anyone who has ever flown a full-size glider knows the thrill and mystery of this exciting sport. Similar adventures await the model-sailplane pilot as he guides his graceful model through the blue skies, chasing and riding the warm, lifting thermals from hill to cliff and beyond.

Radio-controlled soaring offers fantastic possibilities for relaxed outdoor flying. First of all, there is no ear-cracking engine noise to disturb you or irritate your neighbors. RC-sailplanes are peaceful flying machines and are far less dangerous than powered models. Sailplanes are also less expensive to maintain—the lack of an engine means you will have no problems with vibrations which over the long run will often wear out radio-control gear (unless you take special precautions). You will also not have to contend with fuel bills or broken propellers. These factors are at least part of the explanation for the rapid increase in the popularity of RC-soaring over the past few years.

When you begin with RC-sailplanes, you must consider three main factors: the particular model, the RC-gear, and the flying conditions.

The Model Sailplane

In general, your RC-sailplane must be strong but still light, a combination not easy to attain, especially for an unskilled builder. However, because modern materials offer much better ways of constructing a model, you are far better off than the beginner of just a few years ago.

Your model should not be too small—start off with a wing-

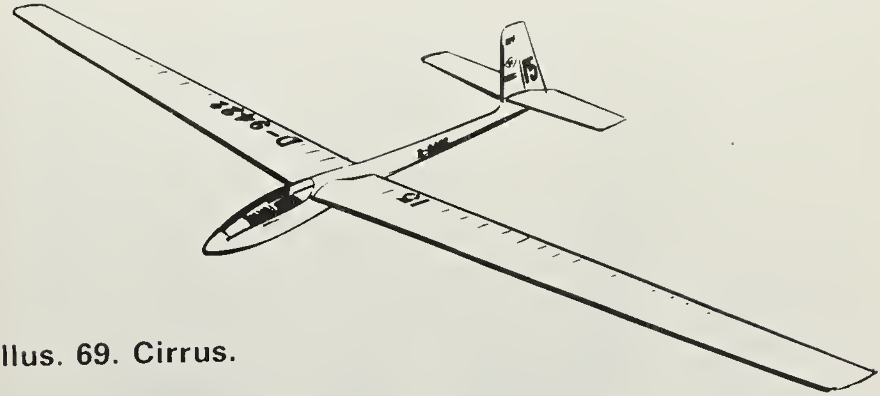
Illus. 68. This completed Cirrus sailplane, handsome as it is, could be improved if the RC-antenna were placed *inside* the fuselage. The rubber band holding the cockpit in place is an unneeded source of unwanted drag.

span of at least 64 inches (160 cm.). Any smaller plane will not have the flying capability that you will want. A streamlined, slender fuselage is, of course, mandatory for maximum efficiency, but you might find this difficult to handle on your first plane. A box-shape fuselage will do for your initial model. Remember, though, to keep the frontal area to a minimum to reduce the drag.

You can fly a radio-controlled sailplane either from a slope with a hand launch or from level ground using a high-start. You can use the same basic model plane for both activities. However, you must adapt your model to the demands of the specific flying conditions, which are dramatically different and require different qualities from your plane.

THE HIGH-START MODEL

A model flown from a high-start (see page 115) faces relatively peaceful air conditions, and little of the strain that the slope



Illus. 69. Cirrus.

soarer will encounter. For general sports flying—including the search for thermals—a model's speed will rarely exceed 22 to 25 m.p.h. (35 to 40 km. per hour). The high-start model needs a good lifting wing section and a low wing loading in order to reduce the rate of sink. Speed is not imperative, but a low rate of sink is the key to successful endurance flights. You can obtain this characteristic by using a wing section with a good lift/drag ratio, and by putting some extra ballast around the plane's center of gravity. The simple high-start model is a fairly large plane with a light wing loading, a good lifting wing section, and a light structure, not nearly so strong as for a slope soarer.

THE SLOPE-SOARER MODEL

A model flown from a slope (see page 116) needs to be sturdier than a high-start model. The slope soarer flies into fairly strong winds off the incline and it must also be able to absorb the shock of bumpy landings on top of the slope. It should be streamlined and have a fast wing section, so that it is able to penetrate a brisk wind. You must be able to change the wing loading quickly and easily by putting in or taking out ballast from a specially built ballast compartment at the model's center of gravity. The slope soarer must also be able to respond immediately to all control functions, and it must have aileron control in addition to the standard rudder and elevator functions. Since slope soarers often fly at speeds in excess of 60 m.p.h. (100 km. per hour), you will need precise control and a sturdy model if your airplane is going to last.

Illus. 70. These three RC-sailplanes and their builders will give you some idea of the size these planes can reach.

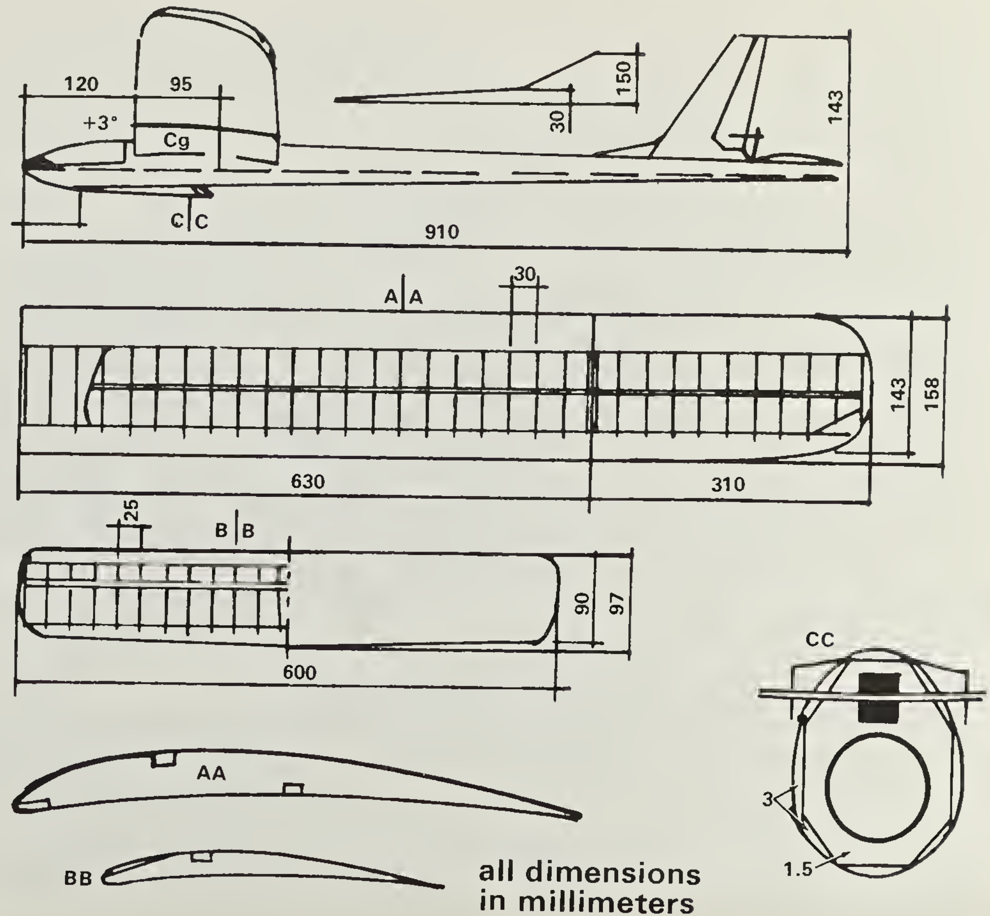
Nordic-type wings (see page 60) are sometimes used on RC-sailplanes by beginners. This wing is adequate for easy flying in absolutely calm air conditions, but it will not perform well if there is any degree of turbulence or wind. Besides this, the structure of a Nordic is really too weak for soaring flight. The stress and g-force that it will encounter will quickly prove too great, resulting in a break and a crash. One final caution: the Nordic-type wing section is too slow. RC-sailplanes must often fly into strong winds, cross through downwind areas, or descend from great altitudes at high speeds. A slow wing section, like the Nordic, cannot handle this kind of flying. As

you will come to realize, the Nordic is built for a very limited speed range—for slow, circling flight with minimum sink. Sailplane pilots are not very interested in this type of performance. Although you will want these qualities to a certain extent, you have a much greater need for speed, wind penetration, good glide ratio, and a strong, but light, structure.

What is the best model plane for a beginner? In most cases a well known, uncomplicated model kit with a wingspan of at least 64 inches (160 cm.). You might get even better results if the wingspan is 84 or 89 inches (210 or 220 cm.). Go to your favorite hobby shop and ask questions. You can also learn from advertisements in hobby magazines.

Instead of a kit, you can, of course, try building your first RC-sailplane from good plans, but again, don't attempt too much too soon. This is good advice even if you are an experienced RC-power pilot, because there is a great difference between flying a power plane and a sailplane. Select an easy project that you can get along with. Ask your friends for advice,

Illus. 71. Amigo is a good design for the novice RC-glider pilot.



Illus. 72. A building plan for the advanced builder.

check with your hobby shop, and use your head. The following list may give you an idea of the degree of complexity and suitability of some of the model kits now on the market.

RC-SAILPLANES FOR THE NOVICE

Name	*Wingspan*	*Control functions*
Lil T	68 in. (170 cm.)	rudder
Windward	68 in. (170 cm.)	rudder and elevator
Dandy	68 in. (170 cm.)	rudder and elevator
Amigo II	80 in. (200 cm.)	rudder and elevator

RC-SAILPLANES FOR THE EXPERIENCED PILOT

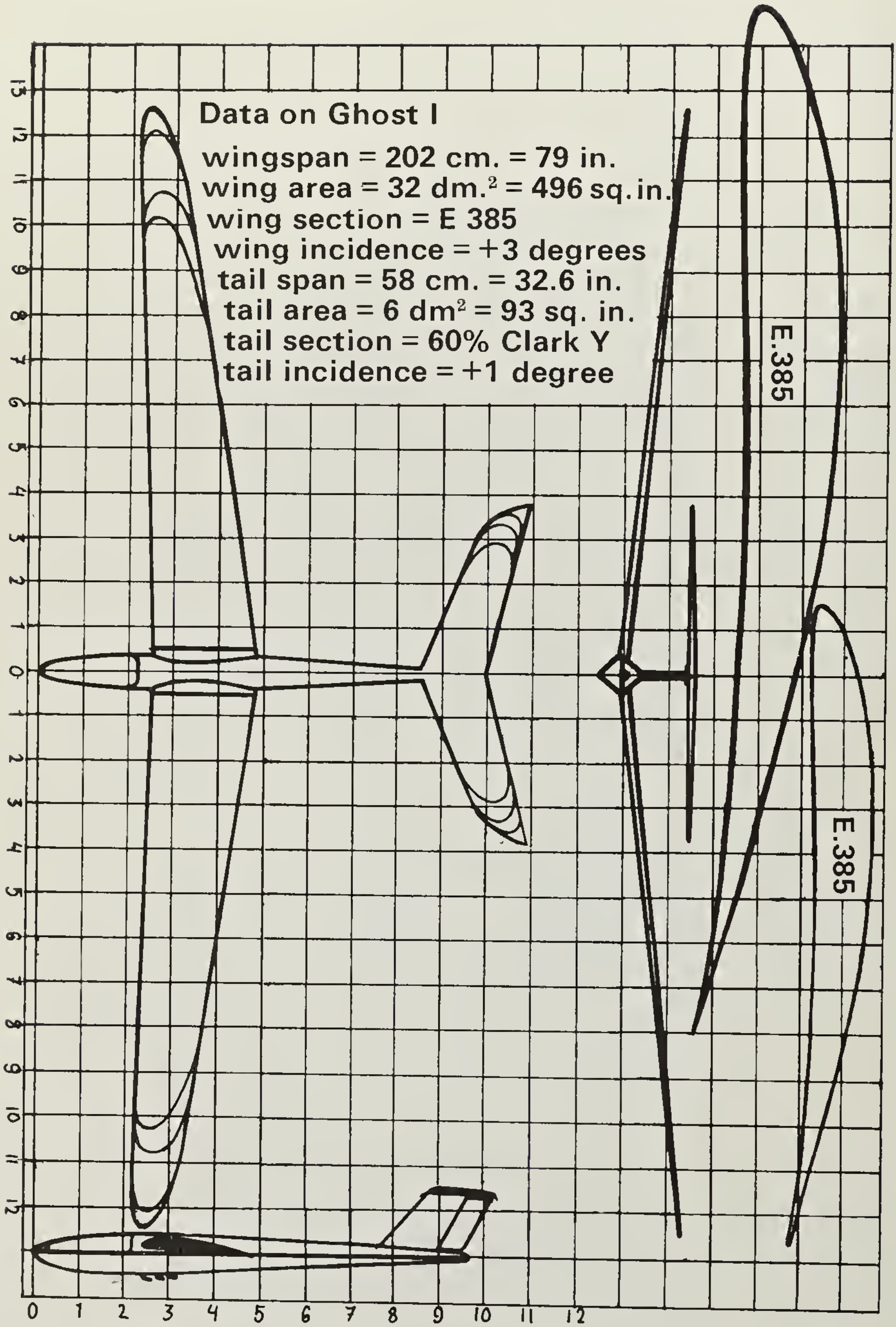
Name	*Wingspan*	*Control functions*
Cumulus	112 in. (280 cm.)	rudder and elevator
Windfree	88 in. (220 cm.)	rudder and elevator
Monterey	92 in. (230 cm.)	rudder and elevator
Olympic	98 in. (246 cm.)	rudder and elevator

RC-SAILPLANES FOR THE EXPERT

Name	*Wingspan*	*Control functions*
Cirrus	120 in. (300 cm.)	rudder, elevator and aileron
ASW-17	140 in. (350 cm.)	rudder, elevator and aileron
Phoebus	124 in. (320 cm.)	rudder, elevator and aileron
Nimbus	140 in. (350 cm.)	rudder, elevator and aileron

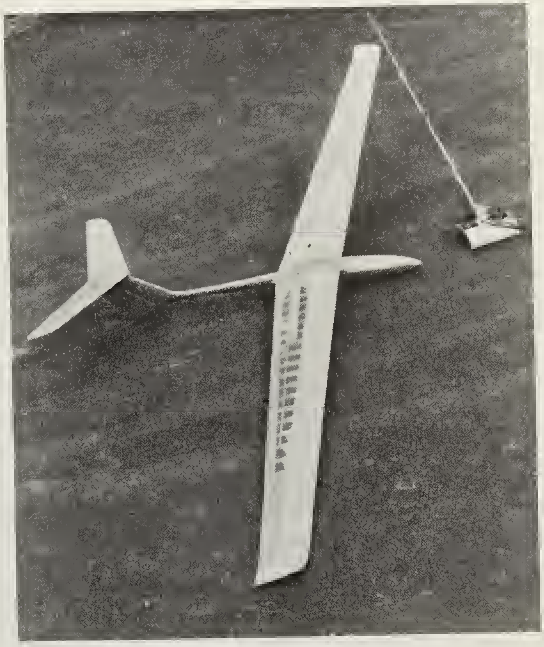
If you have some experience and want to work from your own drawings, the designs in Illus. 72 and Illus. 73 will be of interest to you. The design in Illus. 72 provides control of only the rudder. You can also put in elevator control if you have a small radio receiver.

The model in Illus. 72 is a slow floater and is best suited for calm weather conditions. It is a good model for high-starts, like the Nordic (page 60), and will give you valuable flying experience. Building this model will not cause any great difficulty for a modeller with some experience.

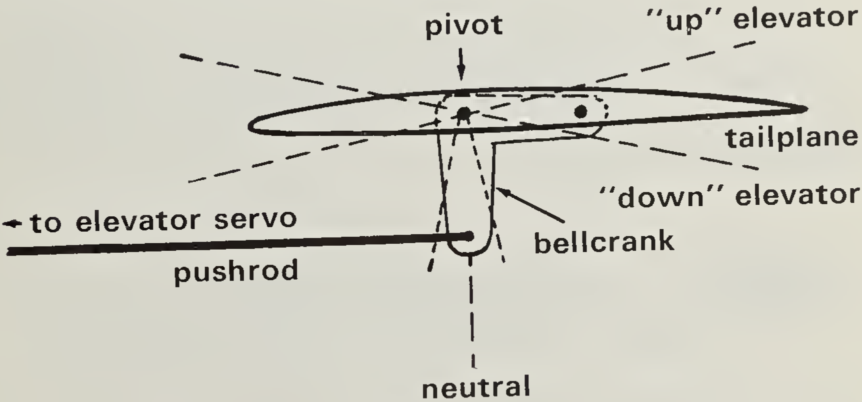


Illus. 73. Four versions of the Ghost series.

Illus. 74. A completed model of Ghost VIII, a complex design for the expert.



The Ghost design shown in Illus. 73 is of interest for those who look for simple, yet elegant lines. Illus. 73 shows the first four versions of the famous Ghost series (Ghost I-IV). They all have the same fuselage, but have different sized wings and elevators. Elevator control is accomplished by the very common "all-flying" tail principle. "All-flying" means that the entire tailplane is moved around a pivot point to produce the "up" and "down" movements. The set-up is shown in Illus. 74. Bellcranks especially made for this purpose are available at hobby shops. The "all-flying" tailplane is easy to set up and offers maximum aerodynamic efficiency.

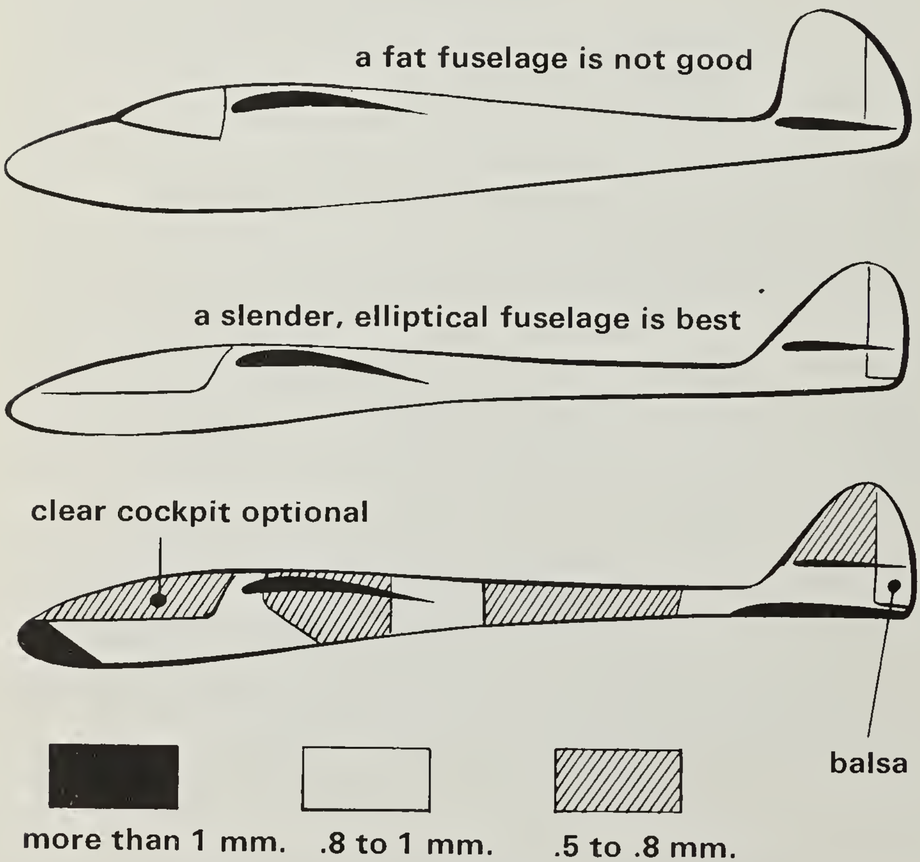


Illus. 75. The "all-flying" tail.

Fiberglass

As you already know, a nice looking RC-sailplane can be built from fairly standard materials. You should also be aware of the advantages that fiberglass offers the model builder. The fuselage in particular takes fiberglass reinforcement well. You can even build a fuselage entirely of fiberglass. Illus. 76 shows a longitudinal section of a common fuselage shape. The shaded areas are stress points (where you will want to add strength). Cover them with 0.8 to 1 mm. of fiberglass cloth plus polyester. The black areas get most of the hard knocks, so you should give these sections a covering of fiberglass more than 1 mm. thick. Use plenty of polyester or an equivalent.

Fiberglass cloth can be used on a standard plywood or balsa structure. Build your favorite fuselage, sand it well, and apply



Illus. 76. Choose a slim fuselage design and reinforce its stress points.

the fiberglass on the places indicated in Illus. 76. The result is a strong fuselage that will stand up to use.

Wings

The proper wing design is essential for all planes, most of all for a sailplane. The secret for a successful wing is found in the shape of the wing section. You also need to know which wing section should be paired to which particular sailplane. Dr. Eppler of Germany is famous for his studies on wing sections for RC-sailplanes. Many good RC-sailplanes fly with wing sections of his design.

Illus. 77.

Dr. Eppler's E. 385 is the perfect choice for thermal soaring over flat terrain. It can give you a tight circling pattern, requiring only small elevator deflections for perfect trim. E. 385 is not recommended for aerobatic flying, nor is it suitable for slope soaring, except under nearly calm conditions.

Illus. 78.

E. 387 may also be used over flat terrain with good results. It is an all-purpose airfoil which is only slightly inferior to E. 385 in circling flight. Though by no means an ideal aerobatic section, you can use it to perform loops, turns, and other simple manoeuvres. It may even be used for inverted flight, but will not give the best performance.

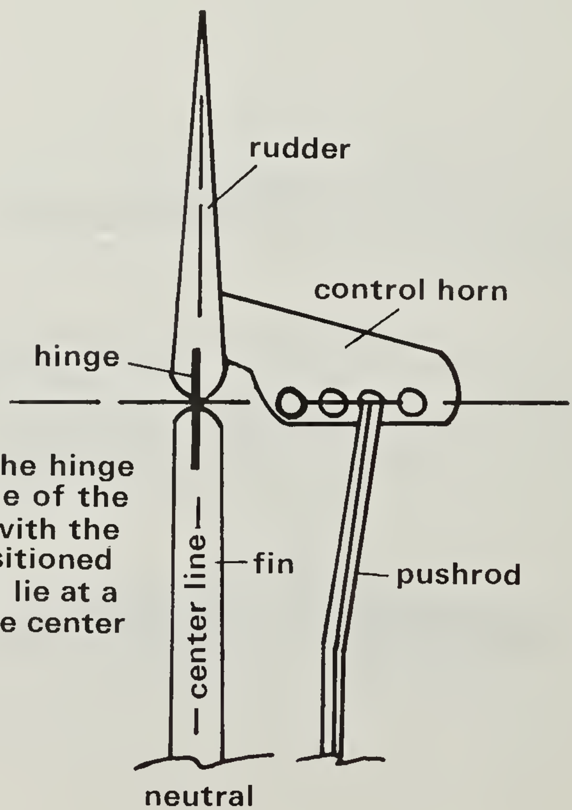
Illus. 79.

E. 374 is designed for use on very fast slope soarers and for thoroughbred aerobatic RC-sailplanes.

You must take care in constructing any one of these wings in order to achieve a high degree of conformity between the computed theoretical airfoil and the actual finished shape. Each of Dr. Eppler's wing sections requires accurate building. Take your time—you gain no advantage by doing a speedy job which comes out badly. Dr. Eppler's wing sections will only deliver superior performance if the wing is accurately built. If you don't want to spend the time and effort, you are better off building from a kit, or, perhaps, switching to a different area of model flying, because RC-sailplanes themselves require the utmost care in building.

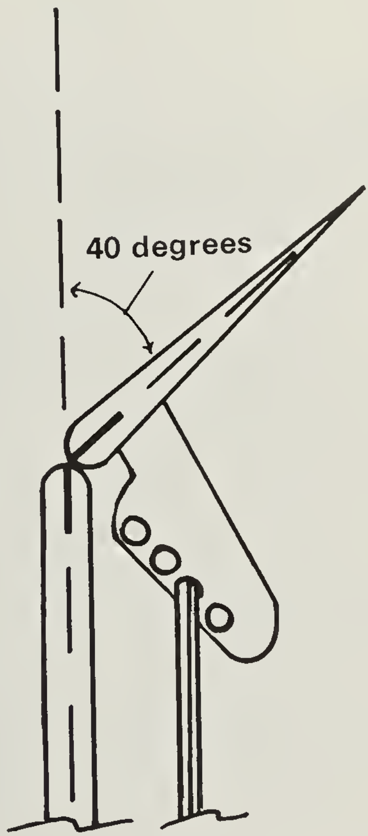
RUDDERS, HINGES AND HORNS

Another important factor to remember is the precision you need in building rudders, mounting hinges and control horns if you are to obtain perfect control of the rudder, and hence the plane, during flight. Try to keep the weight of all rudders down to a minimum. Be careful, however, with any twisting



Illus. 80. Place the hinge in the center line of the rudder and fin with the control horn positioned so that its holes lie at a right angle to the center line.

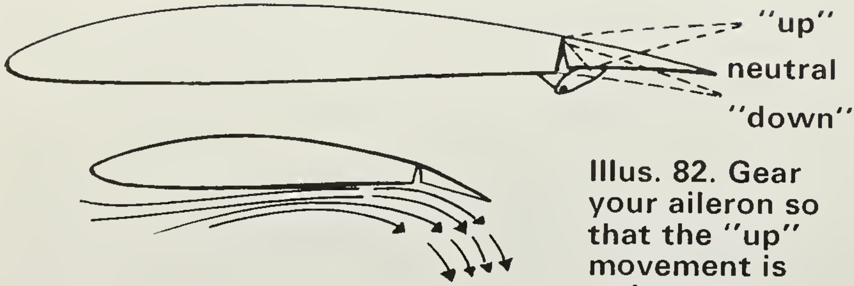
tendencies. All rudders, hinges and horns must be set absolutely correctly. If not, you will lose control of your model. Illus. 80 shows the correct placement of the hinge, directly in the center line of the rudder and fin. In Illus. 80, the control horn is shown correctly positioned, with its holes on a line perpendicular to the hinge line (center line). Careful placement ensures that there will be no deflection when the rudder control is in the neutral position.



Illus. 81. The maximum rudder deflection should be 40 degrees.

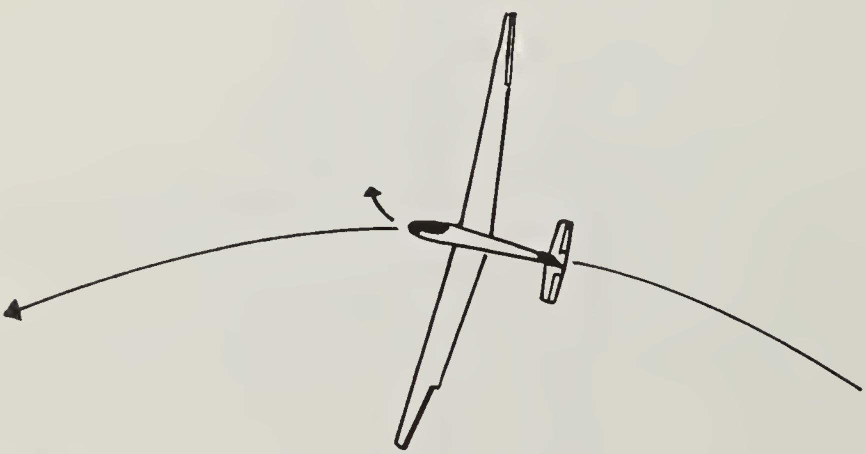
The degree of deflection is a second important factor for all rudders. RC-sailplanes in general need fairly large deflections, especially from the rudder and the ailerons. The deflection from the elevator should be kept fairly small in comparison. A 40-degree deflection is the maximum for a normal rudder (Illus. 81).

For paired ailerons, you need to engineer different deflections for the "up" and "down" movements. The "up" aileron deflection should be approximately twice that of the "down" aileron. This differential action is very important if you are to obtain



Illus. 82. Gear your aileron so that the "up" movement is twice that of the "down" movement.

good roll action and co-ordinated turning ability on an RC-sailplane with its long wings. If the "up" and "down" movements are equal, the aileron going down will usually produce an unwanted drag action (Illus. 82). This becomes quite noticeable in fairly sharp turns, and the plane will fly out of the desired pattern, with its tail hanging behind (Illus. 83). If you gear the "up-down" movements at a ratio of approximately 2 to 1, this tendency is usually eliminated. You could, alternatively, use your rudder to compensate for the drag and in this way keep your airplane's nose down on an ideal curve pattern. In such a case, however, the total drag will be much higher than necessary, and your plane will be performing far short of its potential.

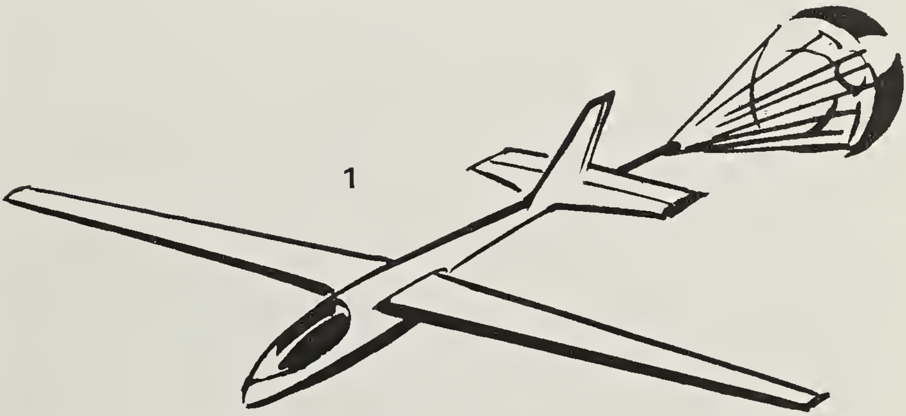


Illus. 83. Too much "down" movement from the aileron will act as an air-brake and cause your plane to depart from an ideal flight path.

SPOILERS

In addition to efficient rudder, elevator and ailerons, all larger RC-sailplanes should have spoilers or air-brakes. These help the plane get safely down from great heights by increasing the rate of sink which allows them to land at a steeper angle of descent. This is helpful if you must land on a small field.

Air-brakes or spoilers come in a variety of designs.

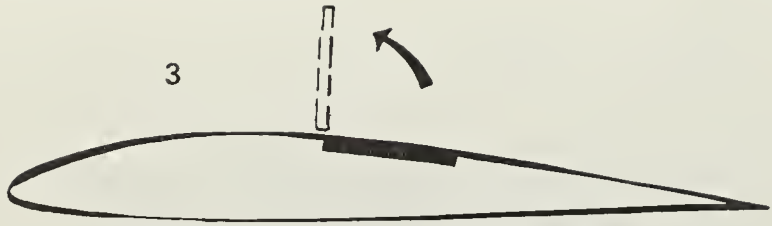


Illus. 84. A drag-chute.

1. Drag-chute. Located in the tail, a chute of approximately 12 inches (30 cm.) diameter is adequate for sailplanes with wingspans up to 120 inches (300 cm.). The chute is secured in a compartment in the tail section of the plane. It is released by a separate servo (mechanism activated by radio control).

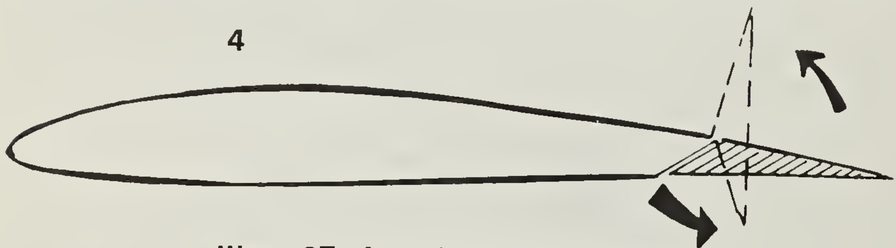
Illus. 85. A top-mounted fuselage spoiler.

2. Top-mounted fuselage spoiler. This requires the simplest connection to the servo, but may interfere with the rudder and elevator, reducing their effect.



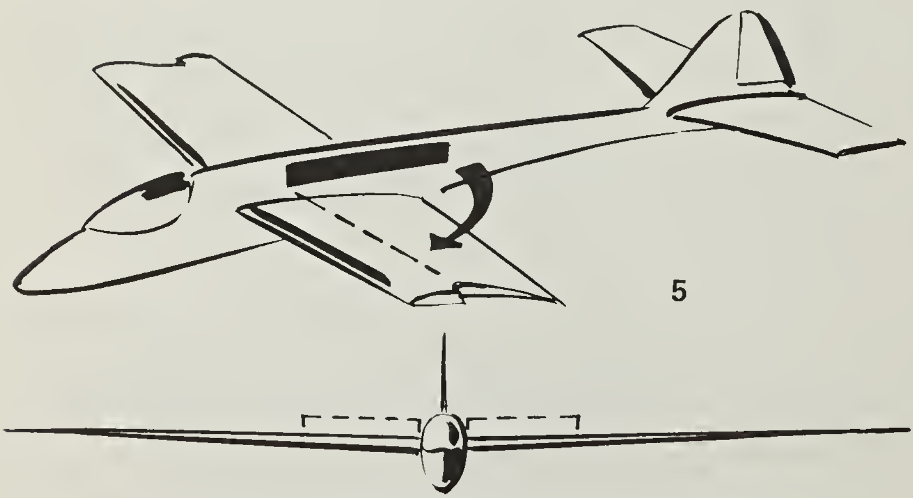
Illus. 86. A wing-mounted spoiler.

3. *Wing-mounted spoilers*. The most commonly used, these are very efficient for their size—a .4×8 inch (1×20 cm.) strip on each wing panel will do. They must be mounted on the highest point of the wing section to produce the maximum drag.



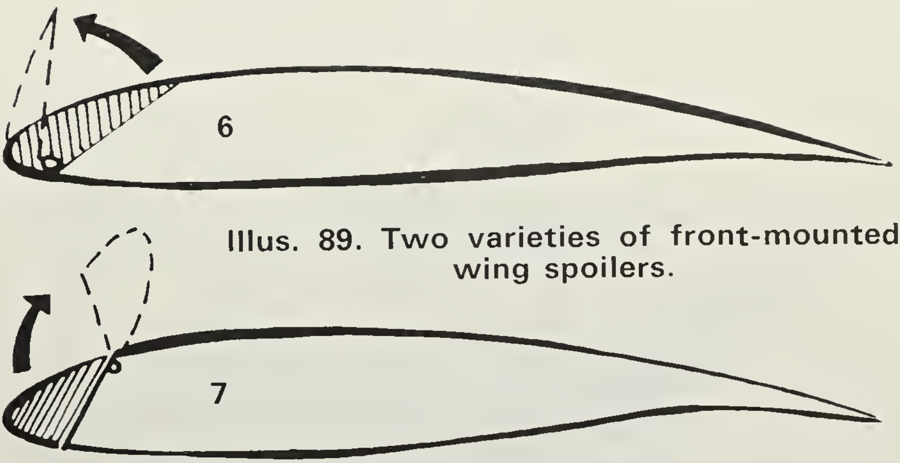
Illus. 87. A trailing edge brake.

4. *Trailing edge brake*. This fairly new device offers a clean wing surface, thus giving a maximum lift/drag ratio.



Illus. 88. A side-mounted fuselage spoiler before and after deployment.

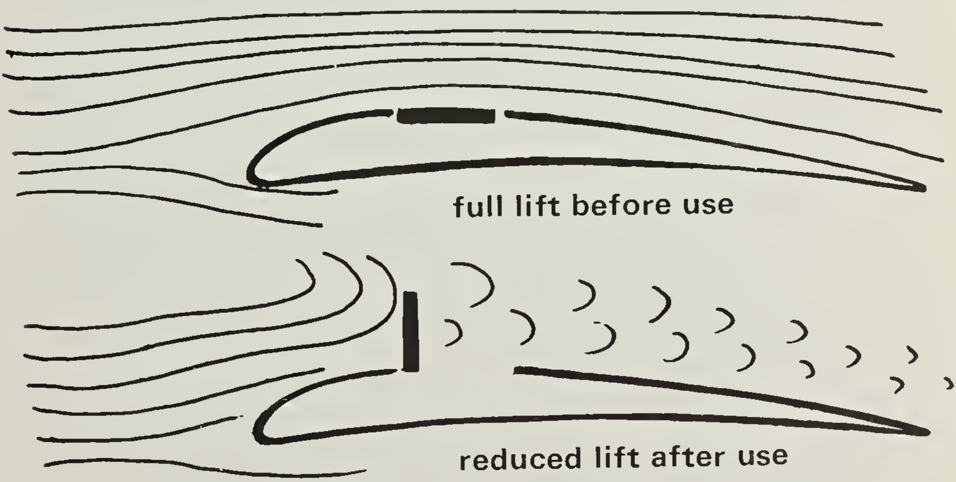
5. *Side-mounted fuselage spoiler*. Mounted on the fuselage, these spoilers swing outward. They offer mechanical advantages, but may interfere with and reduce elevator action.



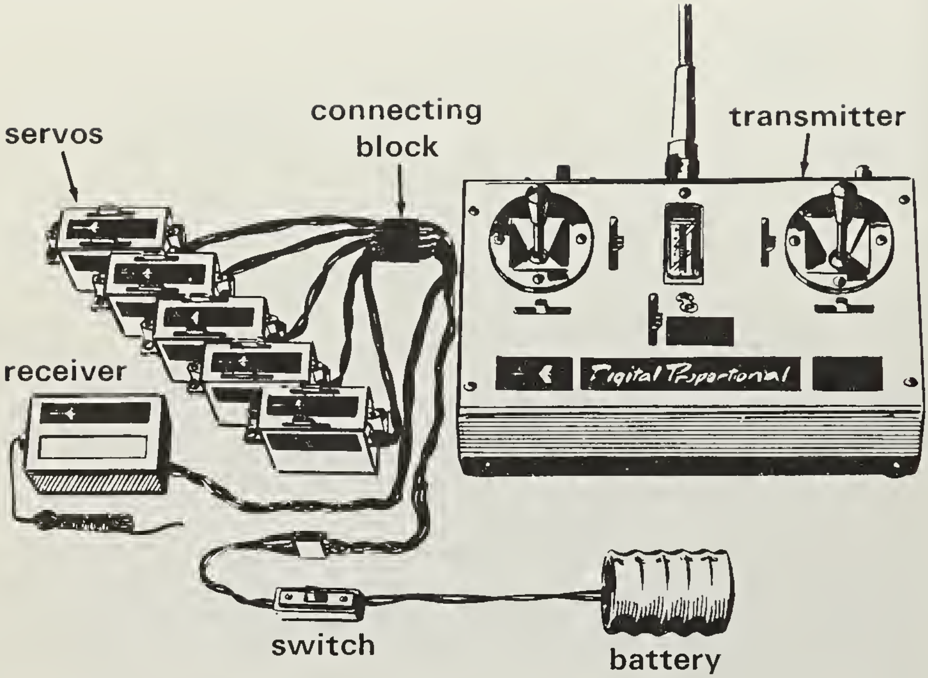
Illus. 89. Two varieties of front-mounted wing spoilers.

6 and 7. Front-mounted wing spoilers. These spoilers are seldom used, but they have a tremendous braking effect. A significant drawback is their forward position, which has the result of reducing lift.

All spoilers achieve their maximum effect when they are deflected 90 degrees against the flight path. They also produce drag, however, at much smaller deflections. By intelligent use of spoilers, you can fly a high-performance RC-sailplane safely in all weather conditions and significantly reduce the chance of wing damage or break-up.



Illus. 90. The airflow pattern before and after use of a spoiler.

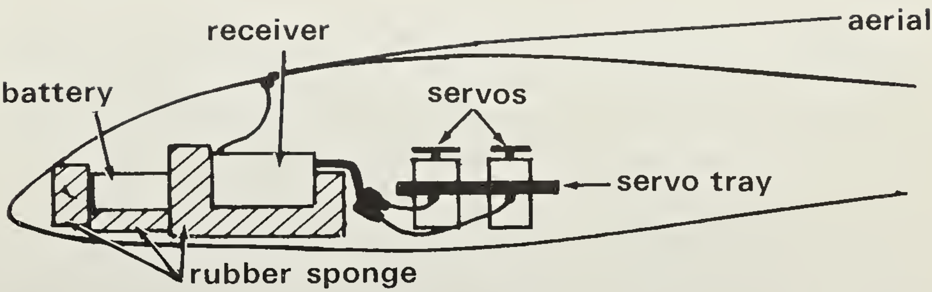


Illus. 91. Radio-control transmitter, receiver, and servos.

Radio-Control Gear

An RC-sailplane requires at least 2 servos—one for the rudder and one for the elevator. A 2-channel RC-unit, therefore, is all you need to start out in radio-controlled flight, and all you may ever need if all your future flying will be restricted to these elementary controls. Very few pilots stay content with the basic unit, though, so the best advice is to look to the future. Buy a 4-channel transmitter, with the accompanying receiver and battery-pack. Then decide on the number of servos you will use on your RC-sailplane. Beginners should still stick to the basic 2-servo set-up for their first plane but will have RC-gear available when they are ready to move up to a more sophisticated model.

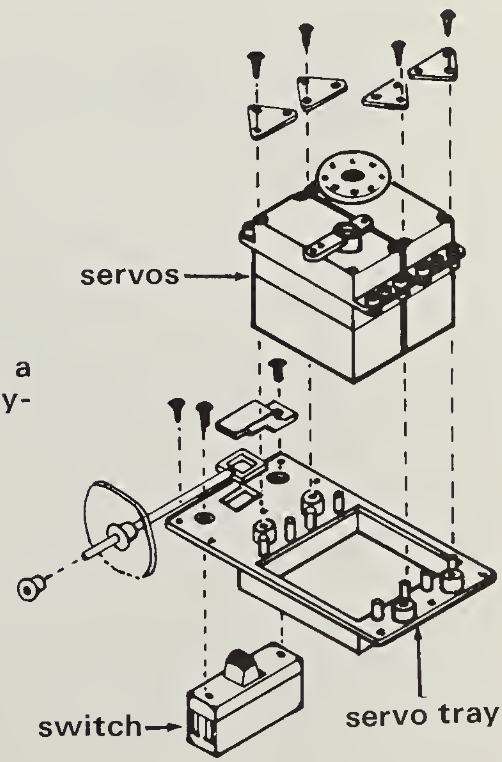
Modern RC-control units are generally of high quality. Each unit consists of a transmitter, receiver, battery, switch, servos and connectors (Illus. 91). Buy a well-known brand, and, good quality equipment. Although it may be somewhat more expensive, a well-engineered unit will pay off in the long run and



Illus. 92. The standard installation of RC-gear in the fuselage of a sailplane.

give you the maximum flight-time for your money. The difference in cost between an expensive RC-unit and a cheap one is usually less than the money lost in a crash.

The actual installation of the control gear in your model varies with the model and the gear. Generally you should follow the instructions given by the manufacturer. Select good quality rubber-sponge and wrap it around the receiver and battery. Then, use a strong rubber band to secure the battery and receiver into the model (Illus. 92). The servo and switch

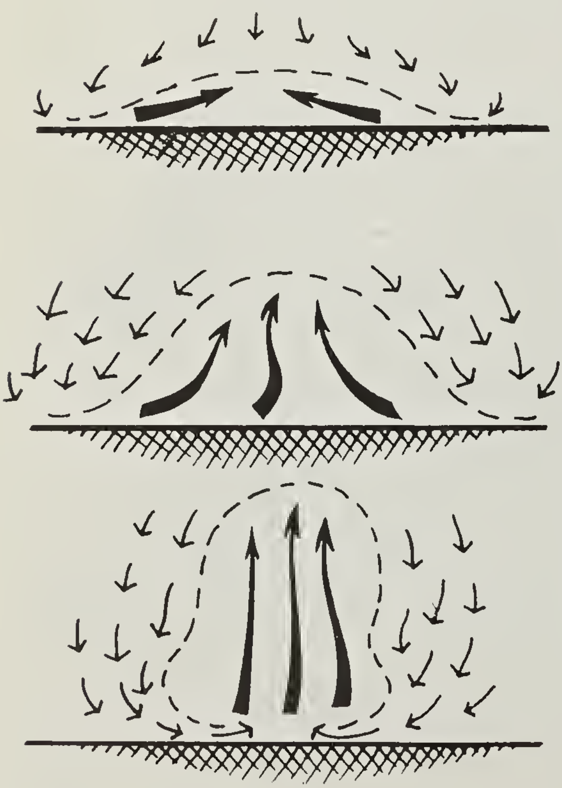


Illus. 93. Two servos, a switch and the accompanying servo tray.

are usually mounted with screws on a platform called a servo-tray. Illus. 93 shows a servo-tray for two servos and the switch. Many RC-manufacturers produce special trays for their servos. Check your hobby shop for specific information.

Flying Conditions

The circling of an RC-sailplane, or a group of them, is a beautiful and satisfying sight. Each pilot strives to manoeuvre into a mass of uplifting air, drawing curves in the sky, showing his skill, knowledge and personality. Anyone who has played this game knows the surge of accomplishment as the climb increases, the wary attention when the plane sinks, the search for position and the need to accommodate others in the sky. This is an exciting sport—it can develop into an art form.



Illus. 94. A thermal is created when the sun heats the ground and creates a low-lying warm air mass. When the warmed air rises, a "balloon" is formed, which escapes the ground and rises. The surrounding down-drafts are caused by colder air rushing in to fill up the vacated space.

Illus. 95. You can expect warm, rising air over easily heated areas—fields, rooftops, rocks. Down-drafts will occur over areas that absorb heat, such as trees and water.

The key to the excitement of silent flight is the thermal. Once the RC-pilot has developed the ability to find the thermal and understands how to exploit it, he finds further challenges that defy written description. You can become this sort of pilot if you first take the time to learn the basic elements involved.

Thermals are warm air masses rising vertically from the earth. They can cover an area as small as a few square feet, or can span an entire acre. The sun fathers all thermals by heating the surface of the earth. The warmed earth, in turn, heats up the overlying air. At intervals this warmed air tries to escape from the earth by rising up like a balloon. The warm air rises more or less vertically with a speed varying from a few feet per second to more than 30 or 40 feet per second!

Thermals are regularly produced over places where the ground can be quickly heated by the sun—cornfields, buildings, sandy soil or rocks. Over such places, the air nearest the ground starts to "pulse" upward with an action similar to pumping up a balloon. Illus. 94 gives a schematic view of the genesis of a thermal.

Efficient flying in thermal conditions depends on putting this theoretical knowledge to the test under actual conditions. Your first 10 to 15 hours of thermal flying are really the introductory course. With slow and systematic progress you will become a successful pilot, learning how to find and ride a thermal.

The three basic elements of RC-thermal soaring are locating thermals, centering into the best lift, and using the height gained in the most efficient way.

FINDING A THERMAL

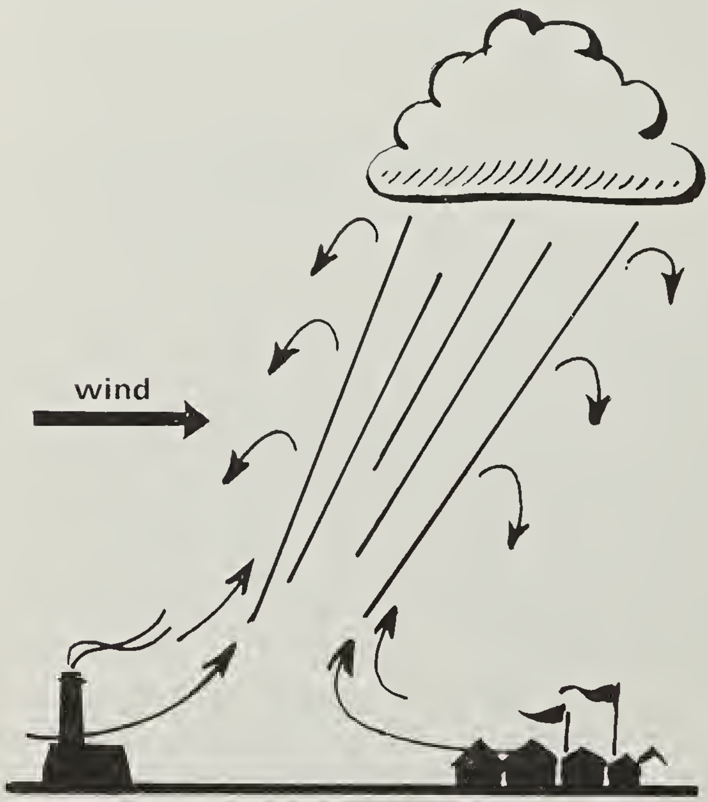
Finding a thermal is a matter of familiarizing yourself with the tell-tale signs of nearby thermal activity. These signs include:

(a) smoke trails (and windsocks) at variance with the general surface breeze.

(b) soaring birds, especially seagulls in autumn and winter.

(c) birds chasing insects—usually swifts and swallows. (You usually will have a difficult time noticing this activity at any distance.)

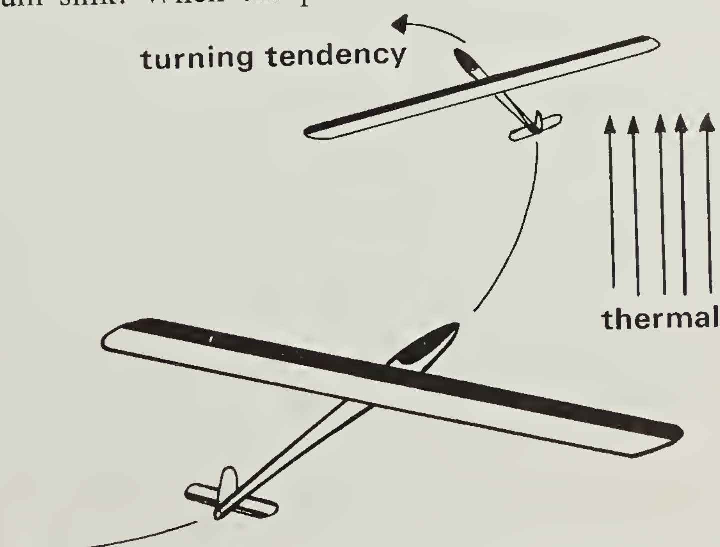
(d) dust rising from dry fields and other areas. Dust is usually only visible for a very brief time, but it indicates that a vigorous thermal is forming.



Illus. 96. Watch the movements of flags and smoke for indications of thermal formation.

Don't let the number of possible clues mislead you into thinking that thermal flying is easy. This is, as you will undoubtedly discover, not the case at all. The nature and quality of the thermal activity in your area will vary from the "big boomers" to ordinary thermal-cones. But no matter what your local conditions, the art of locating a thermal is rather difficult. You will clearly see your sailplane climbing after it has been flying in a thermal for some seconds. The problem is to recognize that you are in a thermal at the exact moment you fly into it.

Finding your thermal is appreciably easier with a slow-flying Nordic-type soarer (see page 60), whose low flying speed makes any vertical movement easier to recognize. A faster model is likely to "blast" through a narrow thermal-cone without your ever knowing you have been in a thermal at all. An ultra-fast RC-soarer is, therefore, not the best plane for your initial training. A more docile model, such as a Kurwi 68 or Cirrus, would serve you better. With a plane of this type you can actually achieve a trim set-up that gives you a sign or warning the instant your plane hits turbulent air. This trim set-up is achieved by relocating the center of gravity to an aft position, lightening the wing loading as much as possible and trimming the model so that it flies a straight course with an absolute minimum sink. When the plane hits turbulent air (Illus. 97),



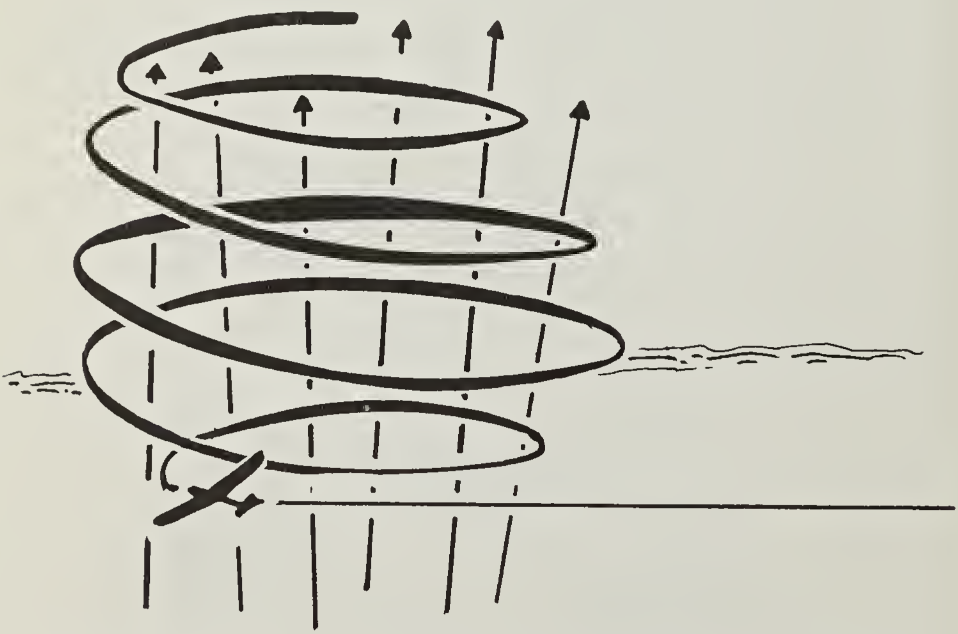
Illus. 97. A trim set-up will alert you to the presence of a thermal.

the wings will dip and the plane will turn *away* from the rising warm air (the thermal). You should immediately turn your plane in the contrary direction (to the right in the case pictured) and try to locate the maximum lifting area. In other words, look for the center of the thermal area, the thermal-cone.

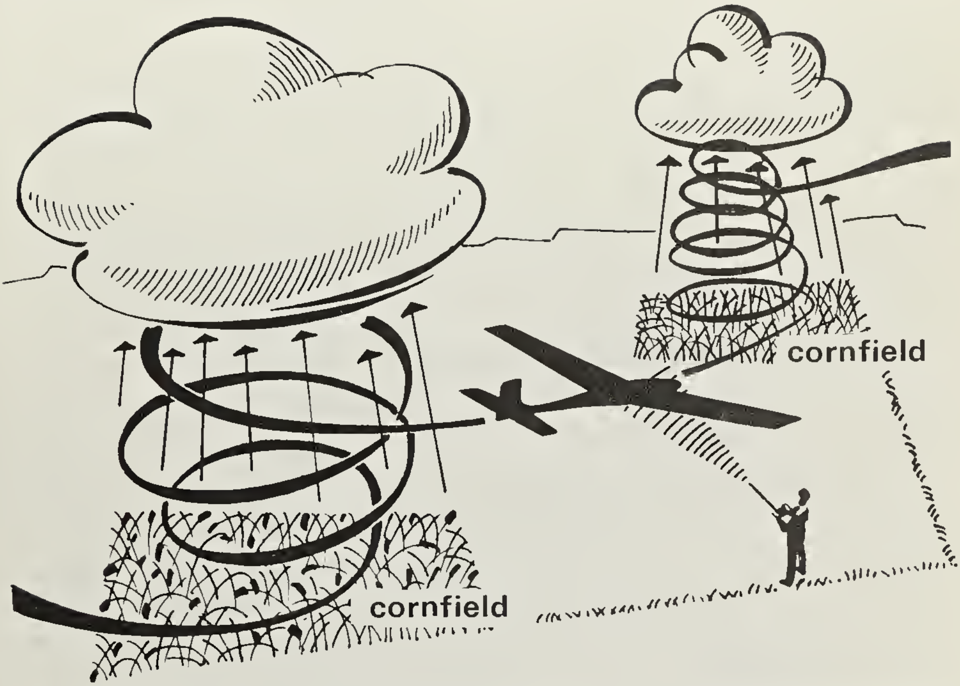
CENTERING INTO A THERMAL-CONE

Once you find a thermal area, how can you make the best use of it? How can you locate the thermal-cone? First of all, there are no easy answers that will guarantee you a brilliant climb of a thousand feet or more. Certain basic ideas, however, assure you a chance of gaining height once a thermal surrounds your plane.

If you have ever observed seagulls or other high-flying birds soaring in circles, you will have noticed how expert they are at gaining height by catching and riding thermals. They simply fly their circular pattern in the warmest air. They can also feel the ups and downs of the air stream. Unfortunately, you cannot be that clever down on the ground with your RC-soarer



Illus. 98. Center into the thermal to get the maximum height.



Illus. 99. Use the height you gain in your search for your next thermal.

high above your head—at least not without an electronic thermal indicator. What you can do to zero into the best lift is make intelligent use of some meteorological know-how and searching patterns, and continuously observe your plane's attitude during flight.

Once you have located a thermal area, fly your model in a circular pattern. Most thermals have a fairly narrow base, so you must experiment if you are to use the best circling diameter in order to get maximum height. Watch your model and try to find the air space where you most quickly gain height. A few changes in the circling pattern will normally tell you this. Then, with soft stick-work, feed in the necessary up-elevator trim to compensate for the increased sink caused by the tighter turns you are making.

A strong thermal can be difficult to fly in. You will often have your hands full trying to stabilize and retain control over the plane in the swiftly moving, vertical air masses. Down-trim on your elevator will help you now, but don't forget to neutralize your controls when the model again behaves quietly.

USING THE THERMAL

Centering into the best lift and holding the thermal is a difficult skill to master. Perhaps you have found a nice "elevator" that takes your plane up some hundred feet or more. Then, suddenly, you recognize that it's all over—your plane may even sink rapidly. You almost certainly have flown out of the thermal-cone and into a down-draft area. In this case, get out quickly by feeding in a little down-elevator and fly straight ahead for 10 to 15 seconds, preferably against the wind. Then, begin another search pattern up-wind to pick up another "boomer."

How can you use the height you gain in the best way? You can start a real cross-country flight, headed for a specific target. Such distance-flying is challenging, both for the pilot and his sailplane. Fly a straight pattern to a far-away target, or fly a wide triangular pattern and measure the time spent getting back to your starting position. Either course resembles a full-scale soaring activity and is very popular with the leading RC-sailplane pilots.

Illus. 100. Einar Myr of Norway is the world record holder in endurance flying. With this simple two-servo set-up he kept his craft aloft for 19 hours 19 minutes.

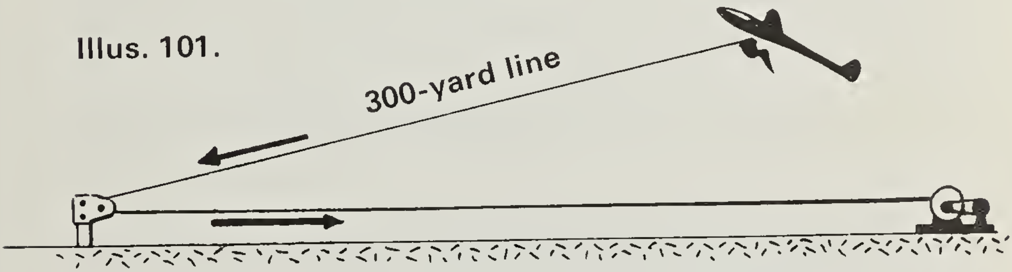
Launching a Sailplane

An RC-sailplane can be flown either from a high-start with a line or from a slope. These are two very different flying situations, and you must treat each one appropriately.

HIGH-START

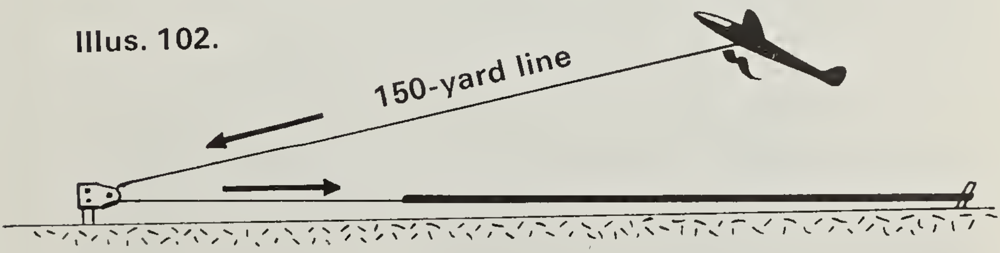
To get your RC-sailplane up to a height sufficient to begin a thermal search, you can launch the model by a high-start. (This is much the same as the procedure you used to lauch a free-flight glider, discussed on page 56.) Two methods allow a pilot to launch his plane singlehandedly, another method requires two people for a successful launch. Illus. 101 shows the use of a winch-and-pulley system. The pilot stands just behind

Illus. 101.



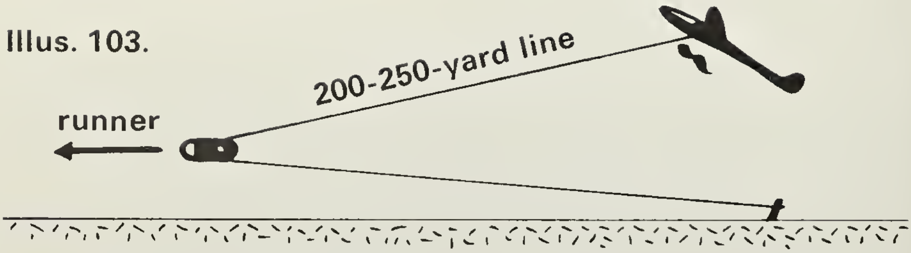
the winch which winds the line up quickly. This pulls the plane towards the pulley, lifting it into the air. The catapult-and-pulley method (Illus. 102) is based on the same essential principle,

Illus. 102.



with the pilot standing behind the ground-peg. For this you need a set-up with a long length of elastic cord, rubber or a spring that can be stretched, then released to launch the plane into the air. Finally, there is the simple line-and-pulley method,

Illus. 103.



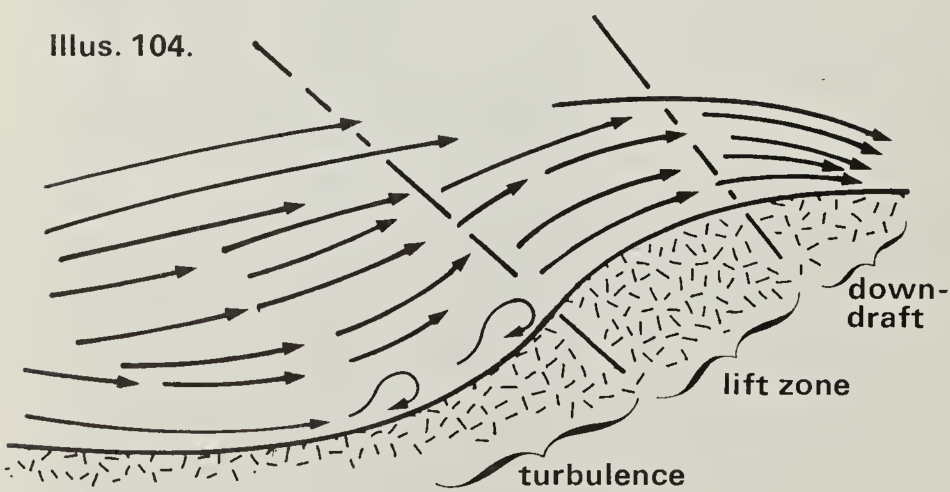
with the pilot again standing at the ground-peg and a runner holding the pulley at the mid-point of the line. The final height achieved by these methods will be less than the length of the line at the start of the launch.

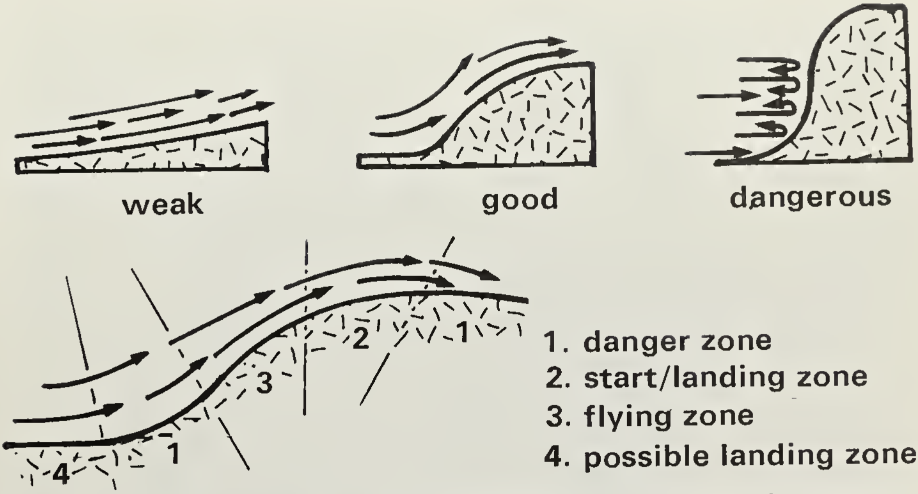
SLOPE SOARING

An RC-sailplane can also be flown very efficiently from a slope, any fairly clean hill or mountain which faces a relatively flat plain. Wind blowing against such a slope is forced upwards, creating lift. The size of the slope can vary, but the general appearance and overall conditions should approximate the diagram in Illus. 104, and exhibit the same shape and air-flow pattern.

The three zones on the hill indicated in Illus. 104 are of great importance in slope soaring. The lift and turbulence patterns of any slope will vary according to the angle of the slope. Illus. 105 shows the general types of slopes and their zones.

Illus. 104.





Illus. 105. Choose a well angled slope and know its zones.

You must understand the turbulence pattern of a slope if you are to use it correctly. You must diagnose its particular lift-characteristics, determine where to fly your plane, and, above all, where not to fly it. You must be especially aware of the danger areas, for any flying there will likely result in a crash.

Illus. 106. Start your plane from the top of the slope with a hefty hand launch.

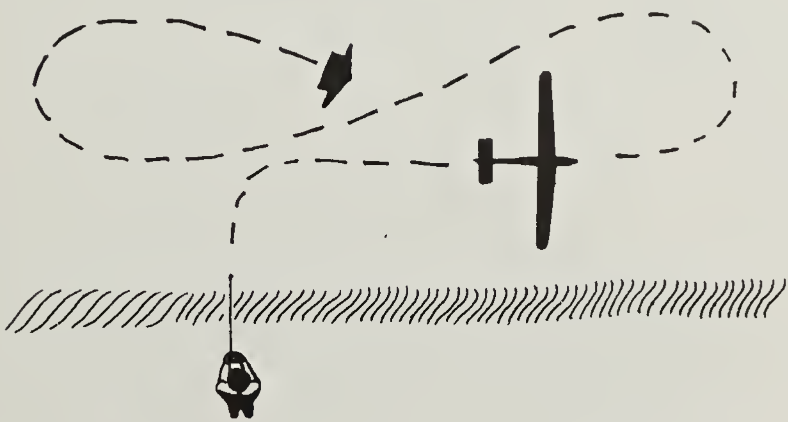
Illus. 107. You can have a friend launch your plane while you man the controls.

The basic flight pattern for all slope flying is a figure eight running parallel to the slope. Start with a hand launch, standing approximately one third of the way down from the top of the hill. Keep the plane on a straight course for some seconds in order to get a safe, initial height, and then slowly turn it left (or right) to fly parallel to the slope. When you reach the end

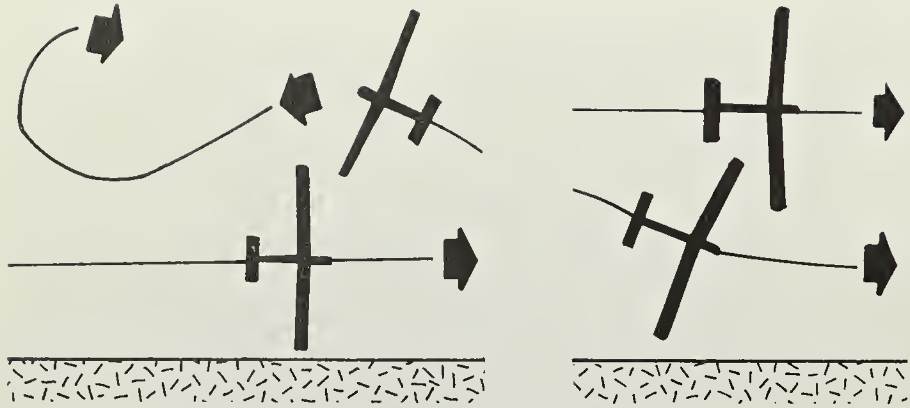
Illus. 108. Fly your plane out from the hill and turn to fly a course parallel to the slope.

Illus. 109. Fly the length of the slope and turn 180 degrees, away from the slope and into the wind.

of the slope, you must turn your plane 180 degrees. This turn is always carried out quite quickly with the simultaneous use of the rudder and elevator. *Always turn away from the hill and into the wind!* Guard against stalling in this turn by feeding in the necessary elevator trim (down please) if you feel your bird "falling off the rails." Fly back towards your ground position, bringing the model almost overhead as it passes, until you reach the other end of the slope. Use the same technique and procedure to turn the model back once more, and you have completed the first figure eight in a standard slope pattern.



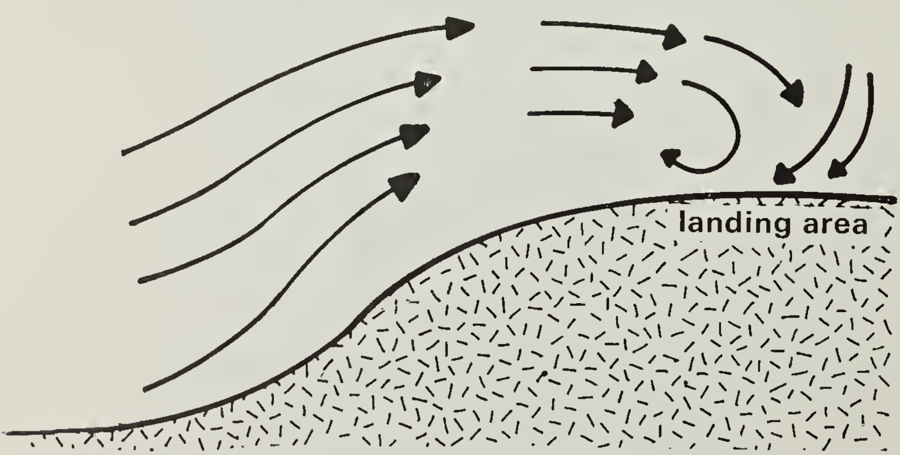
Illus. 110. The basic figure 8 in a standard slope pattern.



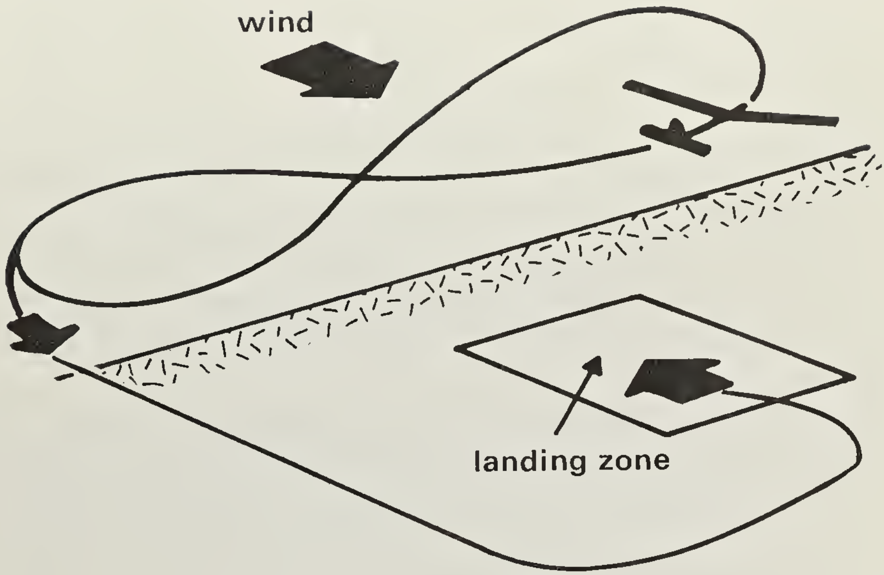
Illus. 111 (left). Keep out from the slope when you meet another sailplane. Illus. 112 (right). Pass planes between the plane and the slope.

Keeping to this strict pattern is somewhat tedious work which demands a combination of observation, flying technique, and careful trimming of your craft. Once you have perfected this manoeuvre, you have a new world open to you—the wonderful world of slope soaring.

A slope soarer should always be flown with the Cg placed at 25 to 35 per cent of the average chord from the leading edge of the wing. Anything further aft of this is asking for trouble. The Cg-position also needs to be adjusted according to the wind-speed and lift conditions of the hill. A fairly weak wind



Illus. 113. Use the down-draft area at the top of the hill for your landing area.



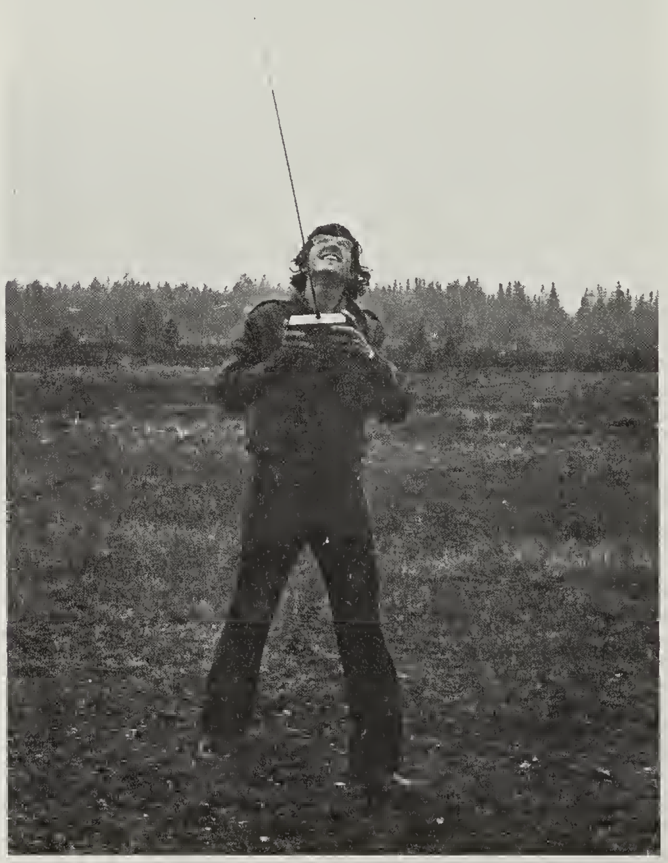
Illus. 114. Bring your plane around so that you will land into the wind.

Illus. 115. It takes great skill to land a plane on a slope.

(5 to 10 knots) can be handled easily with the Cg set at 30 per cent of chord, while a strong wind (25 to 30 knots) requires that the Cg be placed forward to 25 per cent of chord. In this latter case you must also attach additional ballast firmly to the fuselage just under the Cg.

In general, a forward Cg combined with a fairly high angle of attack is preferable to an aft Cg with a small angle of attack. For your first flights especially, you must keep this in mind to insure the survival of your plane during the initial trimming flights.

Study the sketches which represent the fundamentals of slope soaring and, with some hours of practice, you will be well on your way to being a qualified RC-sailplane pilot.



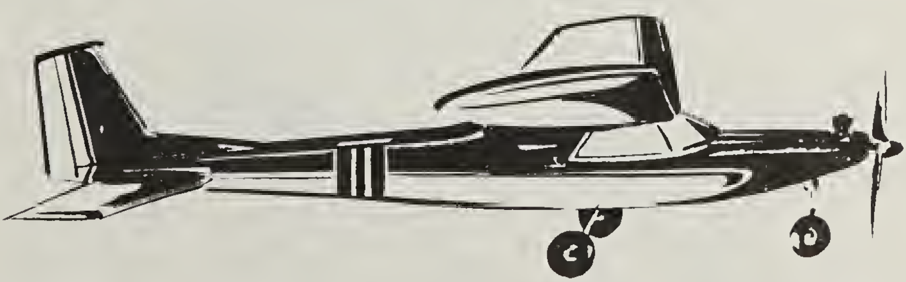
Illus. 116. You need good eyes and a strong neck to fly an RC-sailplane.

Radio-Controlled Power Planes

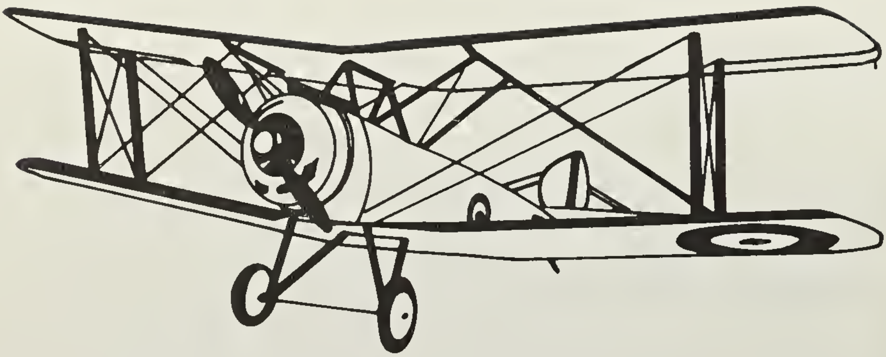
Obviously, the main difference between RC-sailplanes and RC-power planes is the use of a motor. There are, however, many other differences not so immediately evident and the two categories must be handled separately.

An RC-sailplane is dependent upon thermals or slope lift to obtain height, distance, and speed. The RC-power plane, in contrast, can taxi, take off, perform aerobatics, and fly according to the pilot's will, independent of the vagaries of the winds. An RC-power pilot can perform brilliant aerobatics and speed flying with his plane, the only limits being his own skill and the condition of his machine.

Many newcomers to this part of the model flying hobby get their first "ignition" at a model aircraft show and, soon afterwards, rush to the nearest hobby shop to buy a nice looking kit, RC-gear, and engine. Now they want to fly! Their enthusiasm leads them to shoot way above their ability and to pick an over-sophisticated model that should be taken on only after 2 or more years of solid practical experience. An uncontrolled



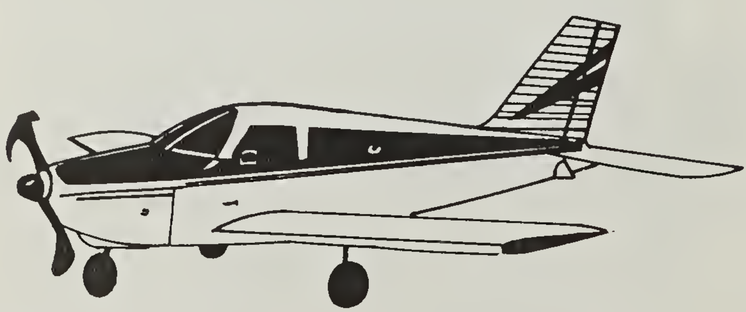
Illus. 117. This sleek high-wing model could serve as a fairly simple trainer. It would make a good second model.



Illus. 118. Stay away from an advanced model like this until you have some building experience and flight time.

plane is a potential hazard to its pilot and anyone else who happens into its flight pattern.

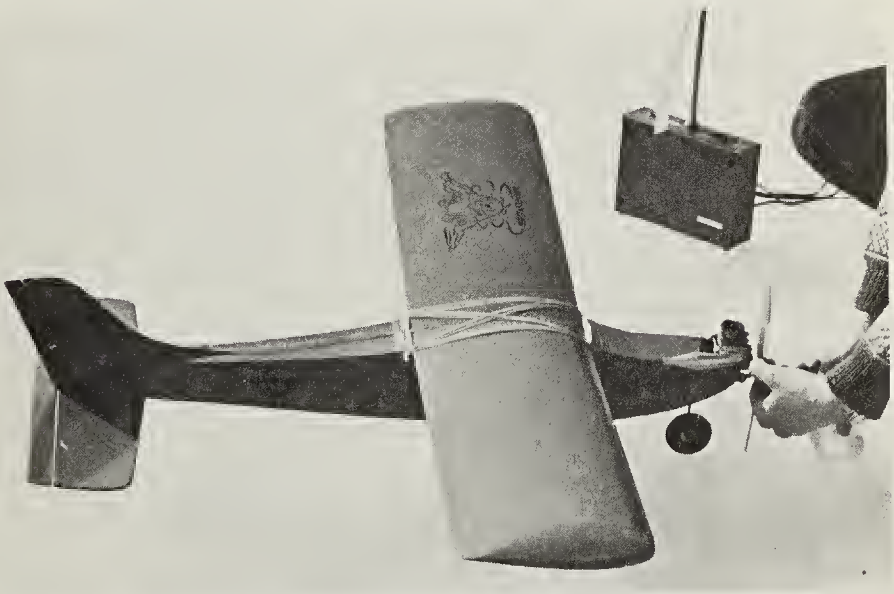
Illus. 118 and 119 show two complicated and fairly advanced models. Coupled with a roaring .60 cu. in. (10 cc.) motor up front, and without the proper control, either plane is a potential danger. Attractive as they are, avoid such planes until you have building and flying experience under your belt. A hobby shop should be able to help you select the proper model. Their personnel should be able and willing to advise the novice, help him select a good trainer, and just possibly, help him out with his first trimming flights. At the very least, the hobby shops should direct the beginner to the nearest RC-club. Flying alongside experienced RC-pilots is a good way to avoid dangerous, expensive, and unnecessary crack-ups.



Illus. 119. This plane demands an experienced pilot.

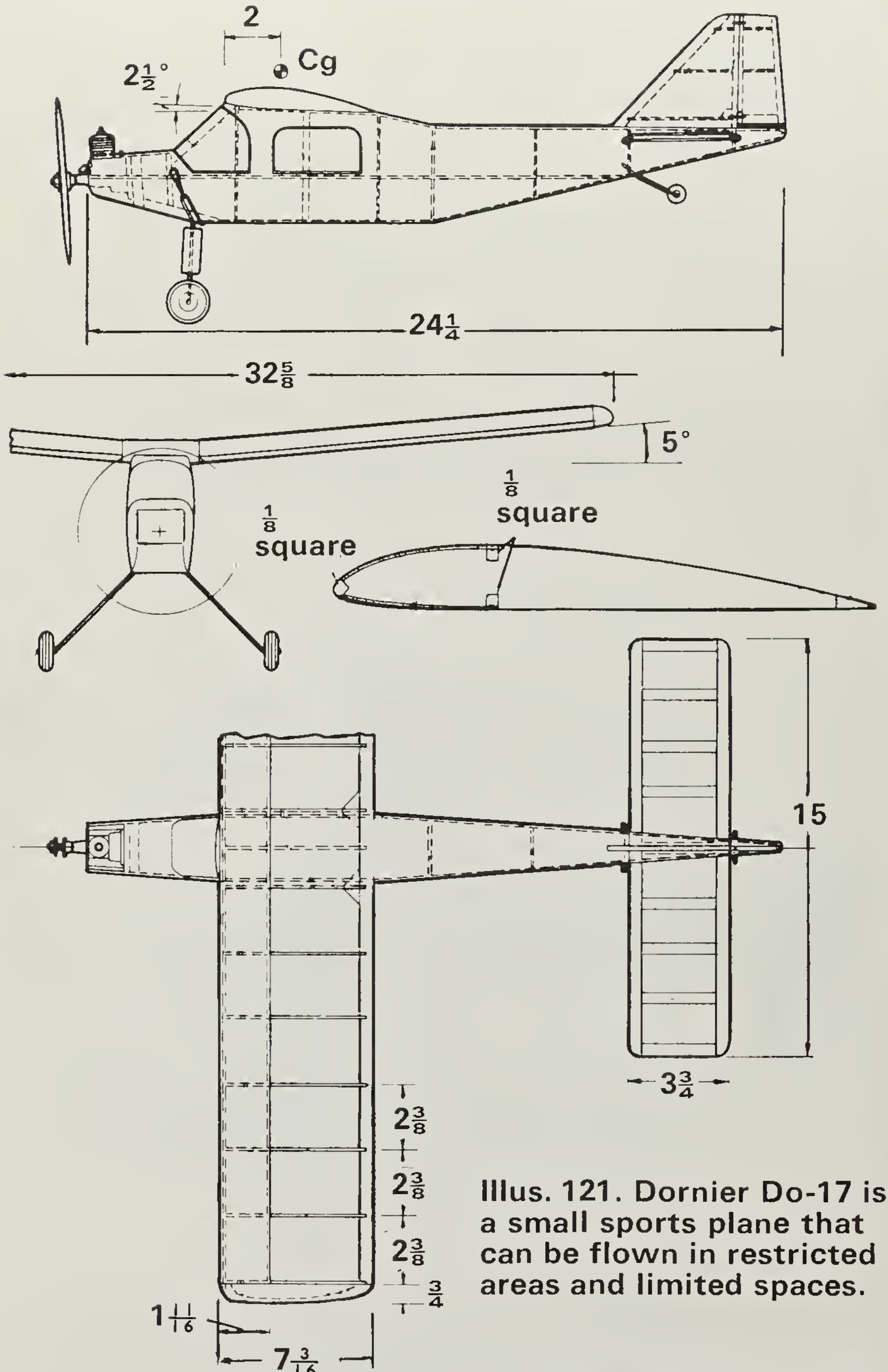
Choosing the RC-Power Model

The great variety of kits on the market poses a problem for the beginner in RC-power flying. If you have no previous flying experience at all, you will have a more difficult time than if you come to your RC-power model with free-flight or line-controlled experience behind you. Experienced or not, it is important that you start with a simple, stable and forgiving design, one with no more than three control functions—rudder, elevator, and throttle. You might do well to start with just elevator and rudder functions. Do not choose a model that is too small and flimsy—you need one that is both sturdy and tough. The Schoolmaster from Top-Flite (Illus. 120) is a good choice.



Illus. 120. Schoolmaster is a good choice for your first RC-power model.

Schoolmaster can be flown with just one servo for rudder control, or with three servos for rudder, elevator and throttle action. It is stable enough for free-flight and it can stand up to a lot of punishment. The model has a wingspan of 42 in. (105 cm.) and can accommodate a motor of .049 to .07 cu. in. (.8 to 1.2 cc.). Its simple but very strong all-balsa design makes the Schoolmaster and similar models good trainers for



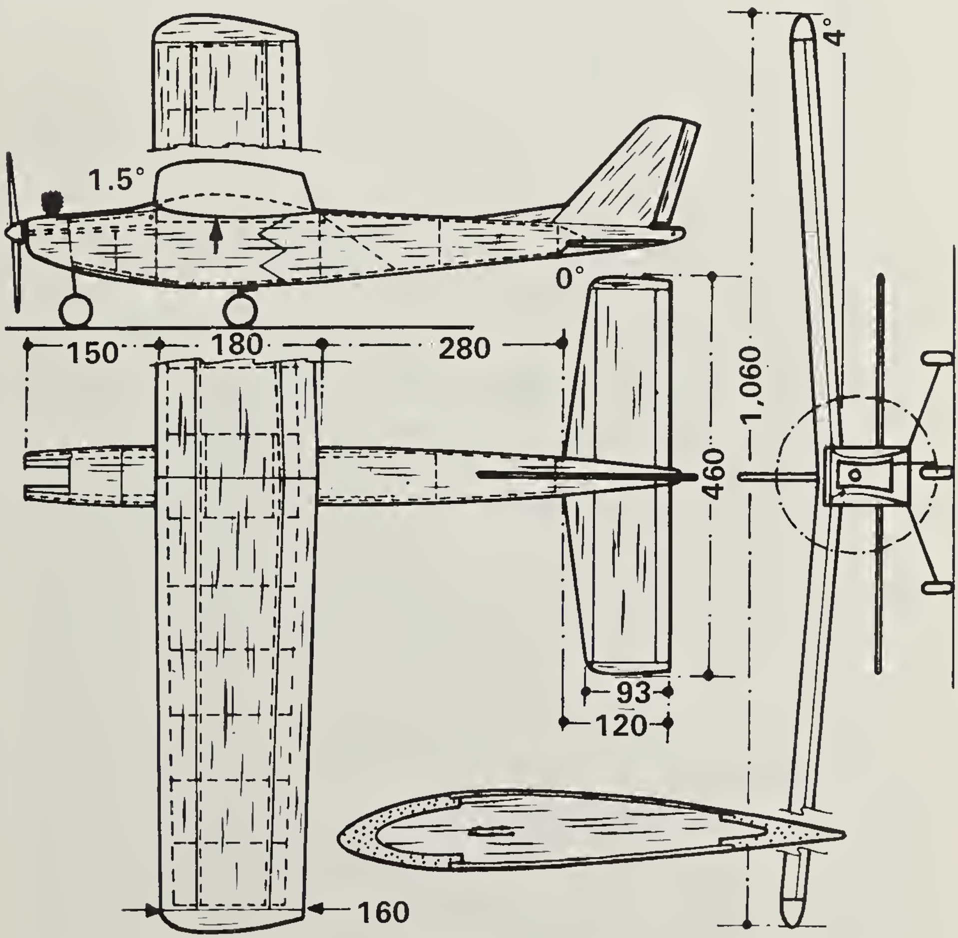
Illus. 121. Dornier Do-17 is a small sports plane that can be flown in restricted areas and limited spaces.

beginners. The box shape permits easy access to the RC-gear and makes installations uncomplicated and servicing relatively easy.

What if you want to build your trainer from a plan instead of out of a kit? You can find many good building plans with complete instructions. Again, your hobby shop should be able to assist you in your choice.

If you have the confidence and experience to make your own building plan, follow a good basic design for the general structure. Be careful to enlarge the plan accurately, or you will end up with faulty construction. Illus. 121 is the basic outline for a small sports plane that you can fly in restricted areas. It is light but still robust, uses a small engine (a motor of .049

all dimensions in millimeters



Illus. 122. Mikado is a more advanced project for the RC-power pilot, but it can also be used as a trainer. See Illus. 40 also.

cu. in.—.8 cc.—will do), and you can fly it on single-channel equipment with control of the rudder only. This design comes from Japan and has become popular with RC-sport pilots of all ages.

If you want a more advanced building project that still produces a plane you can handle easily, Mikado (Illus. 122) may be your choice. It has an all-balsa construction with simple lines, and is powered by a motor of .07 to .15 cu. in. (1.2 to 2.5 cc.). You can fly it on two servos (rudder and elevator) or three servos (rudder, elevator, and throttle). It has a maximum weight of 3.5 lbs. (15.8 kg.).

A POWER-GLIDER

Besides the typical radio-controlled power models, there is yet another way to approach RC-power flying—with a power-glider. This method has not been greatly used in the past, probably because RC-sailplane activity has only recently become widespread.

An RC-power-glider offers excellent training for a power-flying novice. Such a model is easy and inexpensive to build and the maintenance is negligible. Most important for a beginner, though, is that a power-glider flies slowly and requires only soft rudder and elevator action. A power-glider gives you time to *think* about what you are doing with your controls, and you will learn more from it that from trying to handle a "hot," speedy power model on your first powered flights. A power-glider with a small motor of .049 to .07 cu. in. (.8 to 1.2 cc.) will allow you some margin for beginner's errors. For your first flight, fill the fuel tank for 3 to 5 minutes of flying. You want your motor to give your model an initial slow, steady, and shallow climb. When the engine cuts off, you are into the glider stage. You must then manoeuvre for thermals and practice your landing technique. The propeller causes some extra drag in the glider stage, but not enough to be concerned about.

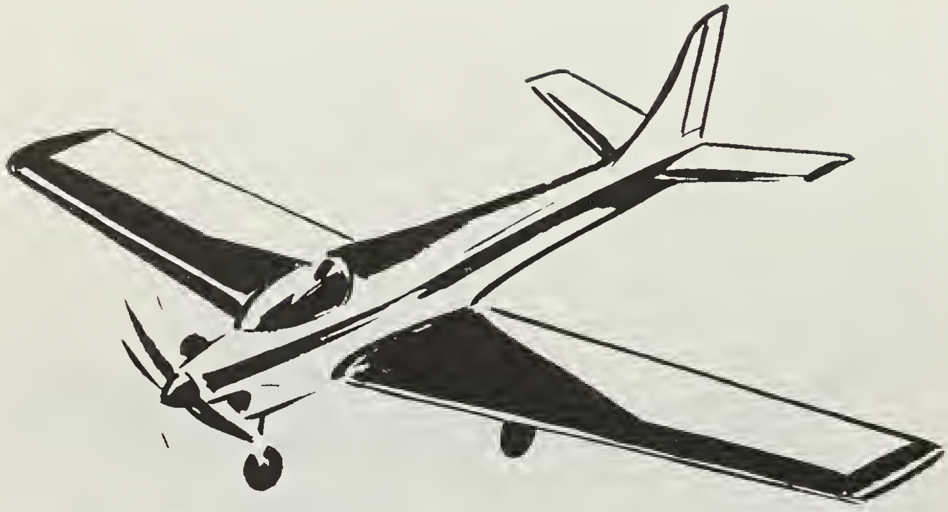
To make a power-glider, use any basic RC-glider of 6 to 7 foot wingspan (180 to 210 cm.) and mount an auxiliary motor on top of the wings or in the nose. You can convert well-known kit models like the German Dandy and Amigo II. You can, of course, also make your own design.

Illus. 123. The Cessna 150 can be operated on two or three servos.

ADVANCED MODELS

Once you have successfully passed the elementary stages of RC-power flying, you are ready for a better looking, more ambitious project. The Cessna 150 in Illus. 123 is an attractive, fairly simple trainer. Itş wingspan is approximately 45 in. (113 cm.) and the model can be equipped with either 2 or 3 servos. The larger, heavier, and more demanding plane shown in Illus. 124 is a Falcon 56. Its wingspan is 56 in. (140 cm.) and it can take a motor of .19 to .29 cu. in. (3.1 to 4.8 cc.) and employ 2 or 3 servos. Both of these models will run uncomplicated flight patterns and are fairly easy to handle.

Illus. 124. The Falcon 56 demands a skilled pilot.



Illus. 125. This stunt flyer is for experts only.

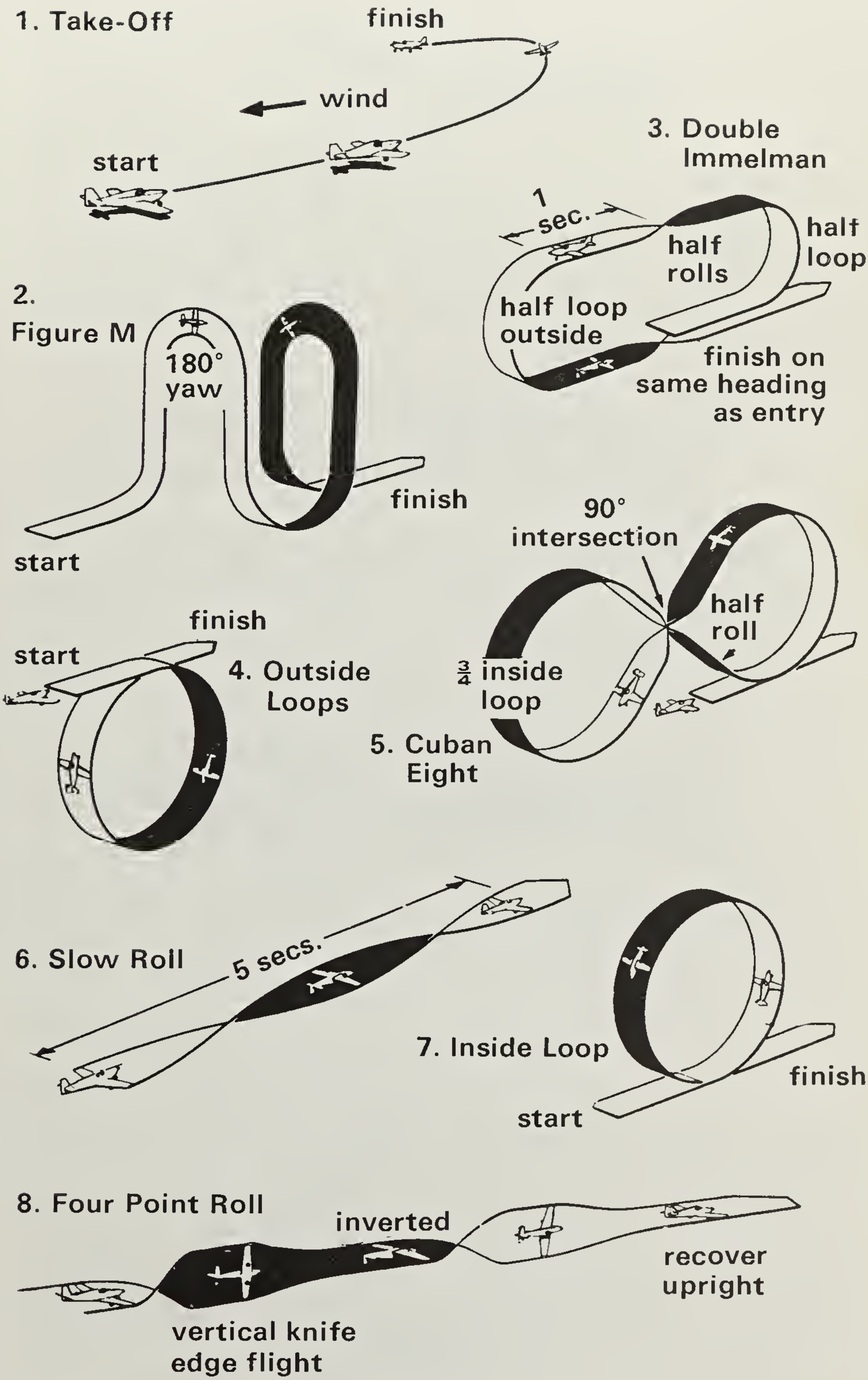
SPECIALIZED MODELS

After a year or two of solid free-flight experience, you will be ready to take on much more complicated and specialized model planes. Perhaps you will be attracted to pattern flying or speed flying. Or you might want a plane capable of performing stunts.

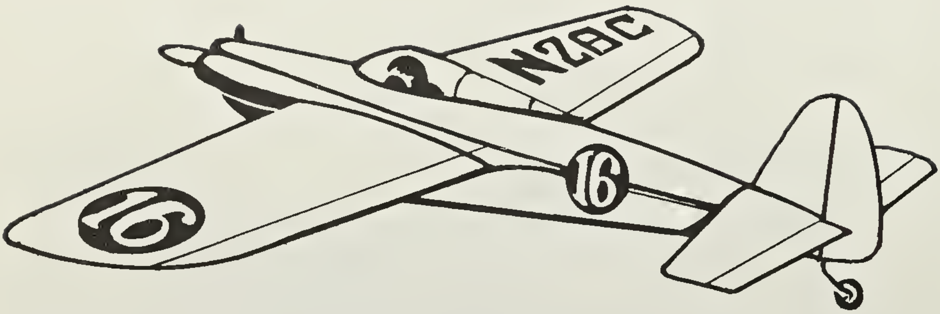
Many expert pilots also go in for scale-model replicas of famous and important planes. This is a challenging aspect of model building.

Any advanced project (especially a stunt or scale model) requires the utmost accuracy in building and much skill and bravery in flying. A typical stunt routine is shown in Illus. 127.

Illus. 126. The detail in this biplane makes it look like the real thing.



Illus. 127. Basic stunt patterns.



Illus. 128. A pylon racer.

PYLON RACING

A highly specialized part of pattern flying is called pylon racing. This is a speed event patterned after the famous Goodyear Air Races.

Pylon racers are typically small, powerful planes that fly at lightning speed. This is a sport only for experts. You need considerable experience in flying standard patterns before you think about entering a pylon race. For qualified pilots, there are many fine kits and building plans available. Fiberglass construction is favored in building pylon racers because of its strength and smooth finish. A good pylon-racing design is Shoestring shown in Illus. 128.

Illus. 129. Typical Goodyear racers.

Building an RC-Power Plane

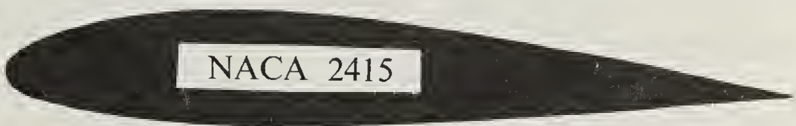
WING SECTIONS

As with RC-sailplanes, you have a variety of wing sections available for the different types of flying. If you are building from a kit, the choice will have been made for you. Nevertheless, you should know about two typical wing sections and their particular advantages.

Illus. 130.

The Clark Y section, shown in Illus. 130, is mainly used on high-wing trainer models because it has good lifting capacity.

On more advanced trainers and aerobatic models, wing sections are almost symmetrical and much thicker than the Clark Y. A typical example is the NACA 2415 shown in

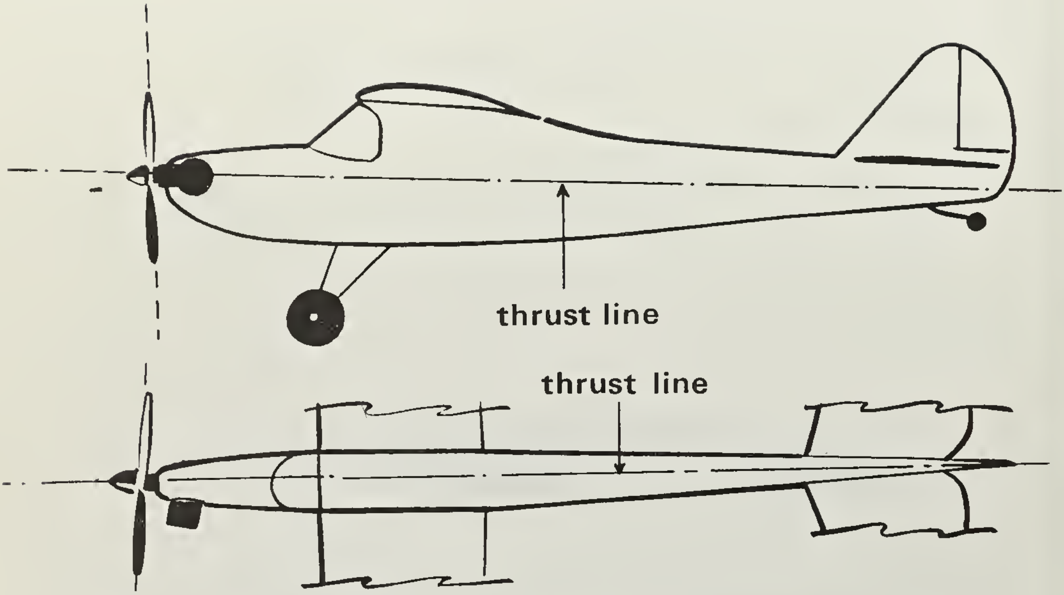


Illus. 131.

Illus. 131, which, in addition to good lifting capacity, can be used for inverted flight. Therefore, NACA 2415 is preferred for intermediate trainers, and Clark Y is restricted more to beginners' models.

MOTOR THRUST LINE

The theoretical thrust line runs from the tip of the nose to the end of the tail (see page 25). In actual flight, the torque created by the turning propeller necessitates a compensating shift in the thrust line if the plane is to follow a straight, true course. An uncorrected thrust line will affect the behavior of your plane and hinder your efforts to fly a pleasing flight pattern. If your model either climbs or turns unduly when the engine is running and the controls are neutral, you must check the thrust line. The size of the propeller, the speed of the motor, and the particular aerodynamic layout of your model are fac-



Illus. 132. You must correct the theoretical thrust line down and to the right.

tors that you must consider when you make this correction. Normally the motor is mounted with the thrust line pointing a little to the right compared to the direction of the flight path. You make corrections by adjusting the motor-mounting until your model performs without undue turning tendency. This is only accomplished by trial and error.

High-wing and low-wing set-ups are quite different. A high-wing set-up should have some thrust-line compensation downwards and to the right to counter the torque (see Illus. 132). A low-wing model does not present the same problem, and you can generally fly it without any compensation to the thrust line.

RUDDER ACTION

The effect of the rudder varies considerably between powered planes and gliders. The slipstream from the propeller of a power plane amplifies and exaggerates the action of the rudder, giving you more powerful and faster-acting rudder response. You must be prepared, however, for an engine cut-off or failure, which can occur at any time during a flight. If this happens, you must be ready for the change in the rudder response and compensate for the resulting lack of effectiveness. All your

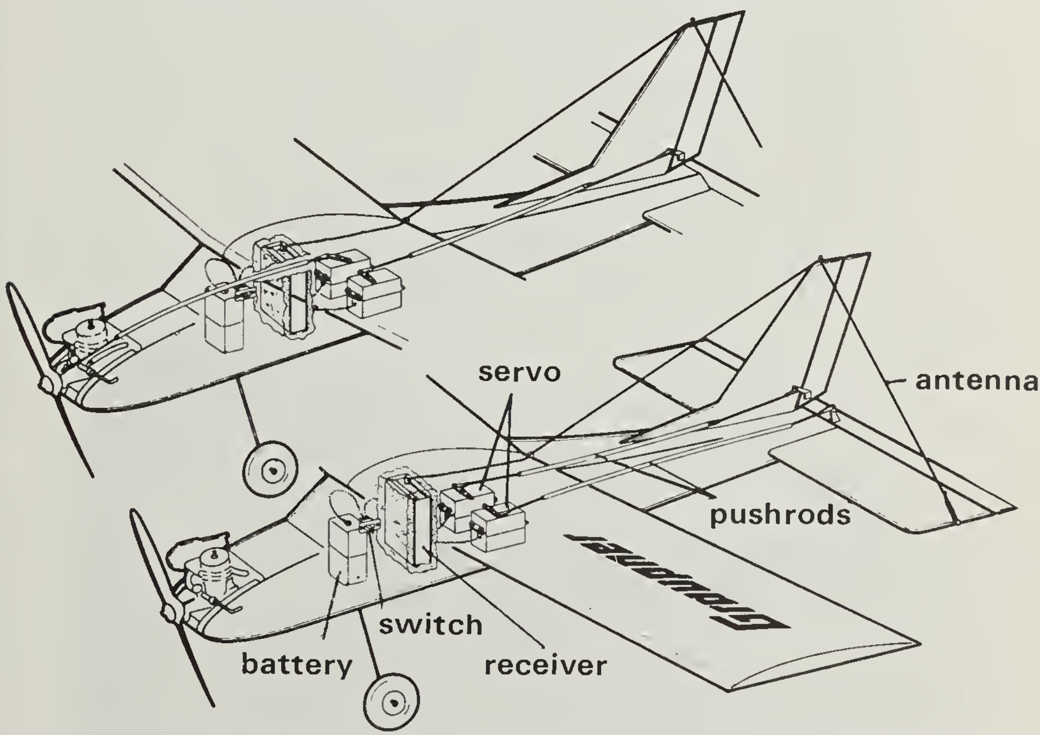
manoeuvres from the time of cut-off to a safe landing must be well planned and executed, because you no longer have the exact control that you did when the motor was running.

RADIO-CONTROL GEAR

The radio equipment for a power plane does not differ essentially from that used for RC-sailplanes. Generally, an RC-power pilot needs the same rudder and elevator controls that are necessary for a sailplane. The addition of a throttle is the major change, and that, you will find, is not a great jump.

Illus. 133 shows two variations of a typical 2-servo set-up. The model at the top has rudder and throttle controls—the lower model has controls for rudder and elevator. These two-control set-ups can be established with standard 2-channel RC-gear. The installations depicted in Illus. 133 are typical for all power planes and can be used as a general guide.

Gear with a third channel gives you rudder, elevator and



Illus. 133. A two-servo set-up in two versions. The top picture shows controls over the rudder and throttle and the bottom picture shows controls over the rudder and elevator.

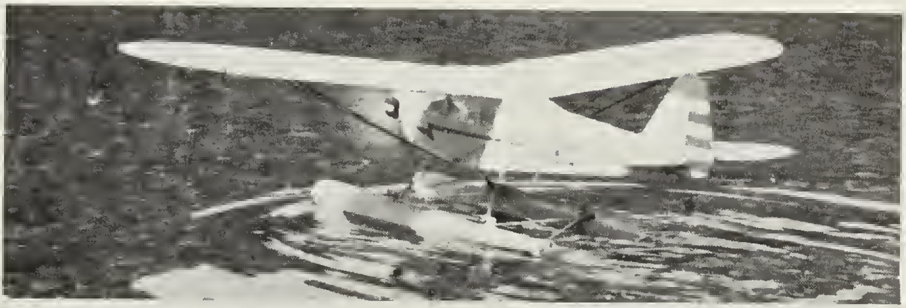
throttle control. A fourth channel lets you add aileron control. You should make these additions one at a time, though, because 4-channel flying can be frustrating and possibly dangerous if you are unprepared.

The best advice is to buy a good 4-channel unit but only the number of servos you need at the moment (perhaps 3 at the beginning). When you are ready to add aileron control, just buy the fourth servo and hook it up.

Power pilots must contend with problems caused by vibration, fuel leaks, and engine exhaust. Failure to deal with these problems will mean a quick finish for your RC-gear. Take the following precautions right at the outset:

- Pack the receiver and battery in good *rubber* sponge, not the plastic type.
- Make the fuel-tank compartment absolutely tight using fuel-proof lacquer which you can buy at a hobby shop. Inspect this compartment regularly to make sure it is still leak-proof.
- Channel the exhaust out on the side opposite the on/off switch.
- Put some rubber bands (elastics) or thin sponge streamers on the wing-saddle to protect it against exhaust.
- Use high-quality push-rods, quick-links, and rudder horns.

Illus. 134. A sports model with a cabin design is perfect for experienced pilots who prefer relaxed flying.



Illus. 135. You can adapt most planes with pontoons for water take-off.

- Inspect the RC-gear frequently and keep it clean.

Most manufacturers include complete instruction and maintenance manuals with their RC-products. Read and study them carefully.

Success in RC-power flying depends above all on intelligent handling of the plane by the pilot. Regardless of how good a pilot you are, you are totally dependent on the black box in your hands. If your RC-gear is bad, you will soon find yourself in a fix—or up a tree. Buy the best quality RC-equipment that you can afford.

Flying an RC-Power Plane

Before you test fly a new model, carefully check the center of gravity, the wing incidence, any warp tendencies, and all control linkages. Check your controls to make sure they function correctly at all motor speeds. Then check your RC-gear with the transmitter at a distance from the plane to be sure of control when your plane is high in the air. Be sure the trim controls on the transmitter are returned to neutral after this final check.

Don't rush through these checks, as they may save you money and weeks of repair work. If you have a friend who flies too, ask him to help with the pre-flight check.

You can start the flight of your radio-controlled power model with a hefty hand launch or by letting it "rise off the ground."

Illus. 136. This pilot checks out his F3A pattern flyer before take-off.

The flying field for an RC-power plane should be a fairly large open area where no one will be disturbed by the noise of the engine. Such an isolated spot may not be so easy to find. Check with the nearest RC-club, or ask at your hobby shop.

Now fill the tank and start up your motor. The ideal throttle setting for the start varies from one motor to another, so follow the manufacturer's advice. Check the r.p.m. from the lowest turn-over to the top speed. Adjust the carburetor until you obtain proper and reliable response. Follow the manufacturer's instructions carefully.

Although you can hand launch your plane, most pilots prefer to have their models rise off the ground. Select the best starting position you can find so that you can begin with a smooth taxi run.

After one final check of the controls, give your plane full throttle and head off into the wind. Concentrate first on

the rudder control, making any small corrections necessary to keep the model headed in a straight line. As your plane reaches flying speed, transfer your attention to the elevator stick. A few degrees of up-elevator will raise the nose of the plane, which then starts its initial climb. Do not let the plane get too far away before putting it into a gentle, climbing left turn by using a little up-elevator and left rudder. Your plane should soon reach a height of about 150 feet (45 m.). At this point, cut the throttle back to approximately half speed or less to stop the climb.

Now get acquainted with your controls, using light movements on the sticks and watching their effect on the plane. Avoid overcontrolling your plane. Do not try any aerobatic manoeuvres on the first 10 or 12 flights.

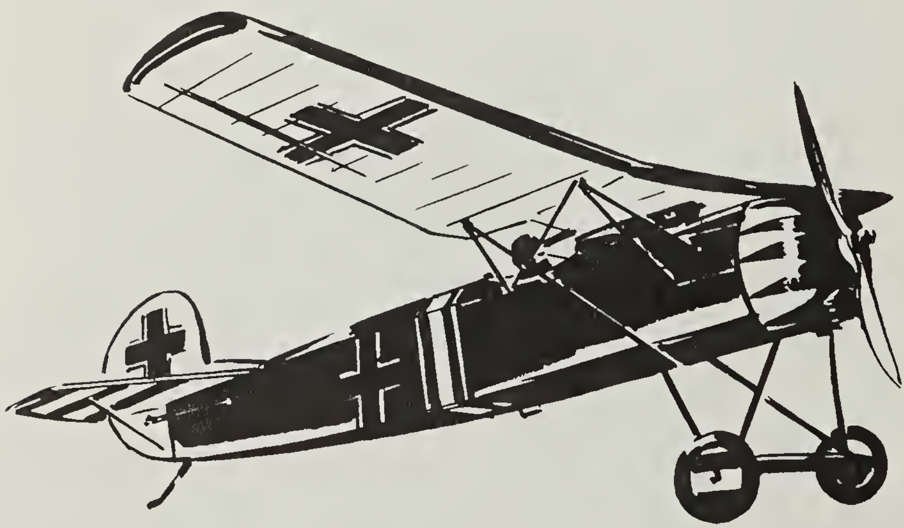
The landing, of course, is an important part of any flight. From the very first you should land in a disciplined manner. *You must fly the model* and not vice versa. Select a landing area before starting your approach and touch down there. This is

Illus. 137. The flaps are down on both take-off and landing.

one area of model flying that takes time and practice to perfect. In the landing procedure, the correct use of the throttle is the most important factor. The motor should be just turning over at the moment the model touches the ground.

A beginning pilot is usually hard pressed to stick to a rigid or complicated flight pattern. A first flight is a success when the pilot lands his model safely and with some accuracy. A good basic routine to follow is:

(a) taxi to a take-off
(b) climb straight ahead from take-off for 5 to 10 seconds
(c) execute a 90-degree left turn and climb for 5 or 6 seconds
(d) make another 90-degree left turn and throttle back to level flight. Fly 5 to 10 seconds
(e) cut the throttle even further back and make another 90-degree left turn. Fly a descending course for 5 or 6 seconds
(f) make one final 90-degree left turn and come in for your landing. Try to land in the same area you used for the take-off.



Illus. 138. Paint and decals will add a realistic touch to your model.

Illus. 139. This line-up of RC-power planes shows the diversity of design possible.

Practice this simple take-off and landing pattern until you are comfortable and proficient with the basic flight procedures. Pilot your plane in a relaxed manner without any abrupt manoeuvres. Make large turns using small deflections on the rudder and elevator. As for the throttle, open it up completely on take-off until you reach the desired flight level. Then throttle back until you are flying a level path with your other controls in their neutral positions.

Continue basic flight training until you are a master of a safe take-off and landing routine—skills you should acquire in 3 to 4 hours of concentrated training. Once these procedures become second nature, you can go on to learn simple aerobatics—loops, wing-overs and rolls. Again, repetition and intelligence are the best teachers.

From then on, the decision is yours. You can continue as a sports pilot or move into the competition field. Your time,

Illus. 140.

special interests and the amount of money you can or are willing to spend on your hobby are the determining factors in this decision.

Static or Display Models

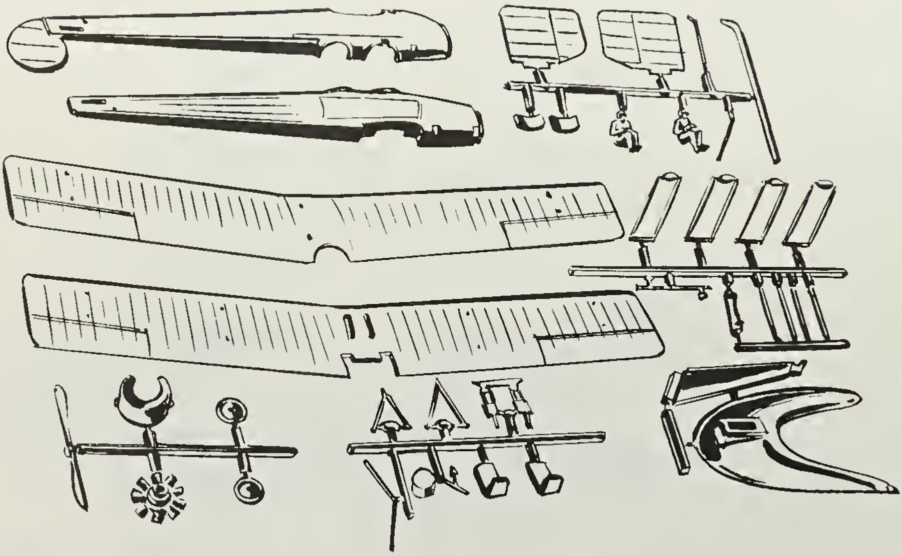
Many model-airplane builders enjoy constructing detailed scale models as the ultimate test of their modelling skill. These static models are for show only—and can be built out of wood or plastic, from solid blocks, or assembled from individual parts. They are usually faithful to the full-size prototype to the smallest detail.

Building a display model requires the same patience that you need with other model building plus some fine work. You will have to invest considerable time and effort in preparing and finishing the model. You can choose from a wide selection of kits, building plans, and other special materials for these models. Some of the smaller plastic kits allow you to work in detail up to 1:72. This means that your model is exactly 1/72nd of the size of the original. The best start you can make is with one of the plastic kits on a scale of 1:48. After about two or three hours of work, you will end up with an attractive model to grace your book shelves. All of the information on building is given with the instructions in the kit, even to the final painting and trim.

After you have worked on a few of these simple scale models, you will be ready to take on more challenging tasks. For instance, you may want to build all of your models to the same scale.

Wooden-model kits are less readily available, but in many ways often offer a greater challenge. You can make either a solid model or one built up from parts in the same way as a flying model. Wooden-model kits often use moulded plastic parts for propellers and wheels. Most of the wooden components are pre-shaped in the factory, but often need some sanding before assembly.

Finishing a wooden model takes time. You first apply a



Illus. 141.

number of coats of clear dope, then a coat of sanding sealer. After the sealer has dried, rub with fine sandpaper to get a glass-smooth surface. When the grain of the wood is no longer evident to your eye or finger, you can apply colored cellulose dope, preferably thinned down to 50 per cent strength. Rub with fine sandpaper between coats. Don't overload your brush—several thin coats make for a smoother, more attractive finish.

When you have finished your model, whether plastic or wood, you can mount it to give the impression of its being in flight. In this case, the landing gear must be secured in against the plane. If you prefer to display your model in the taxiing position, you must cement the landing gear out in its functional position.

As your collection increases, you will want to write down the pertinent data about each of your planes. Do this on index cards which you can then mount beneath each model.

Building scale models is a good way to perfect your building skills and learn aviation history. You might even get a new design idea for your next "flying" bird.

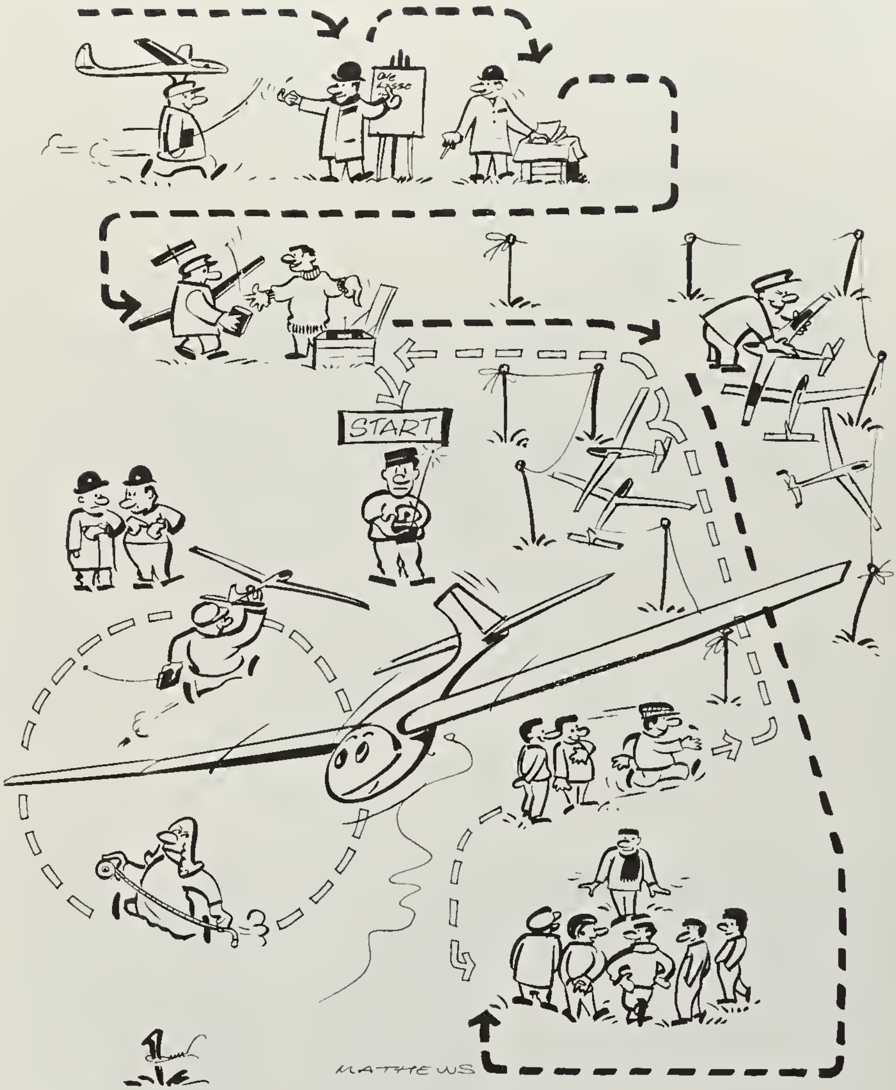
Competition Flying

Flying model airplanes is not just a hobby—it is a high-level sport as well. Each model airplane type belongs to some class of competition. Gliders, sailplanes, powered planes, even model rockets, are put in different competition slots with very specific criteria. Some classes were established so long ago that they become "classics." The "Wakefield" competition for free-flying, rubber-powered airplanes is a good example.

Since rule changes occur frequently, the competition-minded flyer should look to his local model airplane club for the up-to-the-minute information. Your local hobby shop is another possible source of details.

Members of the Academy of Model Aeronautics (AMA)

Illus. 142. A final check of equipment is made before the start of any contest.



Illus. 143.

can, of course, obtain information directly from that organization (see page 4 for their address). The AMA can supply you with rules and specifications for both national and international contests. Also important in this context is the *Fédération Aéronautique Internationale* (FAI) of which the AMA is a member. The FAI rules over and sanctions all high-level international meets.

Why does anyone enter a competition? Can't a model-

airplane pilot be happy simply flying his craft just for the fun of it? The answer is, of course, yes, but there is more to it than that. Most of the technical developments in model airplane design have come about primarily because of competitions. The search for a slight edge in speed or control, for those vital points or seconds that can spell victory, these all spur on the contestants to modify and improve their equipment, design and flying techniques. New technical refinements are born, performances are improved, and all model-airplane builders benefit.

It is not easy to name one particular competition class as the most challenging, although recently, there has been a great surge in popularity of all types of radio-controlled flight. This gain in popularity is probably due to the combination of building and flying skills that are called upon by RC-planes. Also, since each pilot is actually "flying" his plane, it places a premium on the individual's skill.

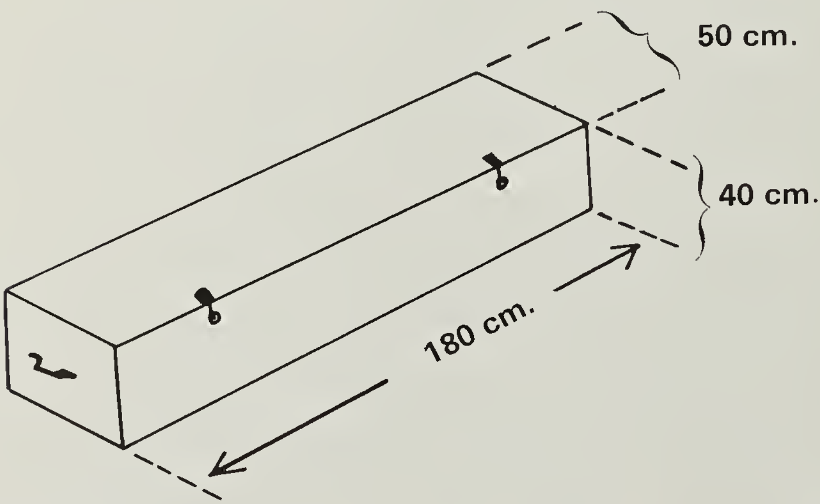
Competition flying represents the top level of the aeromodelling hobby. For some, competitive flying is the goal towards which all of their building and flying experience has been pointing. For other pilots, contests have no such allure; they are satisfied with flying for its own sake. Both kinds of pilots are important for the model airplane hobby. Where is your place in the picture?

Transporting Your Model

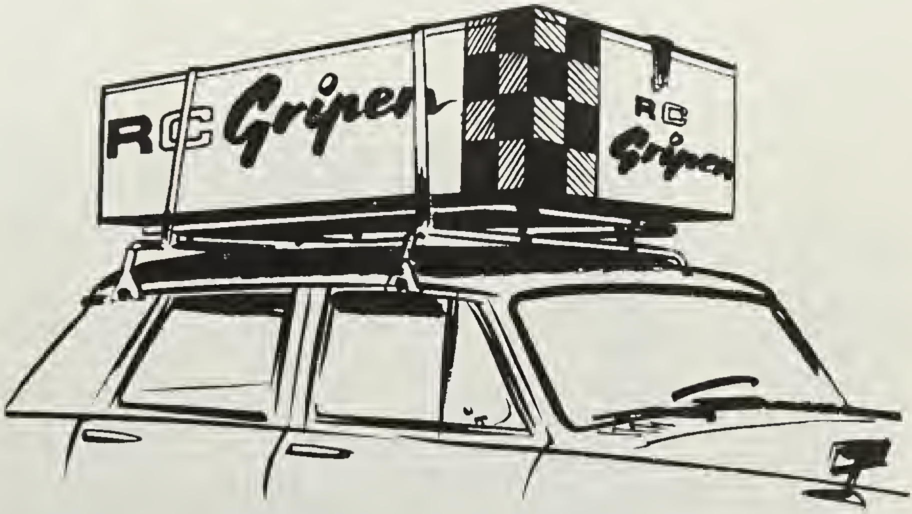
Whether you fly for sport or competition, you will, sooner or later, want a special box for transporting your models. Too many models are destroyed by careless handling on the way to and from the flying field.

Many pilots merely wrap their planes in paper or cardboard, but these soft packages are vulnerable to rough treatment. Others simply break the model down into its major components, and happily stroll along with it under their arms. This is quite a risk as they not only carelessly subject their models to undue strains and possible breakage, they are also endangering themselves and their fellow pilots by operating a model whose vital equipment may be damaged and impaired by this rough treatment. The model may be a safety risk on the flying field, just because of improper care in handling.

Many transportation problems can be solved by a sturdy,



Illus. 144. A simple transport box. Add a lengthwise divider for safety.



Illus. 145. You can strap your carrying box to the top of your car for longer trips.

cardboard box. Usually, though, this will not be enough for the lengthy ride to that far-away flying field where next week's competition is scheduled. You should, instead, build a stronger box out of standard plywood.

The design for your transport box depends on your needs—the type of plane you want to carry and the accessory equipment that goes with it. A line-control pilot will have different criteria than an RC-sailplane pilot. Don't make your box so that it is too heavy or unwieldy when it is fully loaded. If you are planning to strap it to the roof of a car, be sure that it is adequately reinforced to withstand the strain of the restraining straps.

Illus. 144 shows a general sketch for a practical carrying box. With a length of about 6 feet (180 cm.) it can accommodate most larger radio-controlled models, any free-flight model, and all line-controlled models. You may also find it advantageous to put in a lengthwise divider wall to keep the wings and fuselage separate. Add carrying handles and one or two locks to finish it off.

If you get into the higher realms of competitive flying, you may need to ship your model long distances using a commercial

Illus. 146. A bus or van proves a convenient carrier for several planes and accompanying gear.

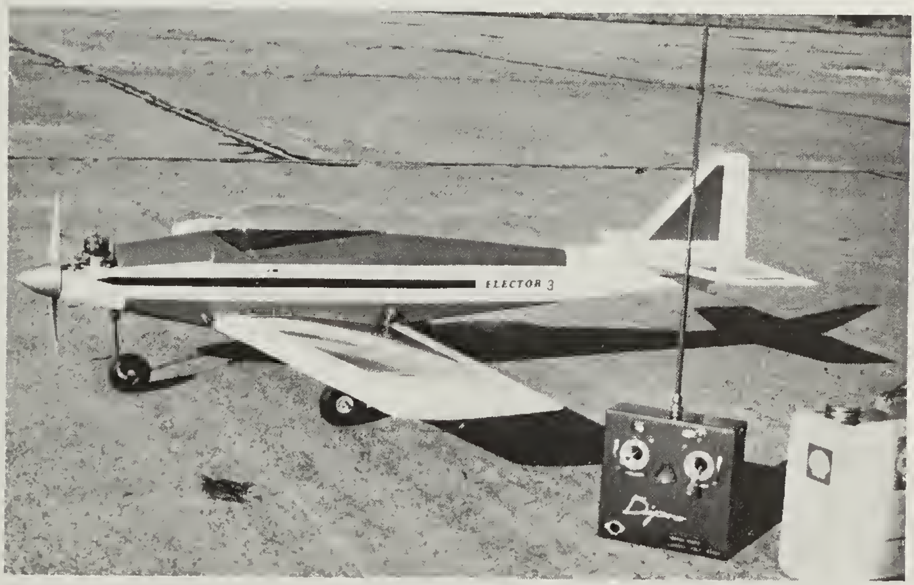
airliner. Be aware that there are size and weight limitations governing air freight, and you must abide by these limits. Check with your local carrier for specific information.

Whether your journey is blocks or hundreds of miles, remember that the proper transport of your model is an important part of flying safety.

Flying Safety

Safety has recently become more of a factor for everyone connected with model flying to consider. The operation of a model airplane can, in certain instances and under certain conditions, cause great damage or injury. You must recognize that a model airplane flying through the air represents considerable inertia. In an accidental collision with a person, a model plane of 6 to 9 lbs. (3 to 4 kg.) flying at a speed of 60 to 90 m.p.h. (100 to 150 km. per hour) can have the same effect as a bullet. These accidents are not only tragic in themselves, but they threaten the continued existence of a wonderful sport and hobby. All model airplane enthusiasts must take every possible precaution to avoid accidents.

The construction, trimming and daily maintenance of your model plane are major factors in flying safety. A hastily built



Illus. 147. Safety in building, care, and flying is of paramount importance when you graduate to a powerful pattern ship or stunt flyer.

model is more likely to be of inferior quality than one on which you have taken your time. The latter model is usually more accurately put together, has greater strength and can take more punishment. A properly built and painstakingly trimmed model flies more accurately than one built slap-dash, and if it is controlled by lines or a radio, can be steered with greater control.

These general safety rules apply to all categories of model planes. Certain types have additional requirements as well. The following suggestions are adapted from rules of the Academy of Model Aeronautics and should be followed at all times.

General Safety Precautions

Do not fly any model aircraft in competition or in the presence of spectators until it has been proven airworthy in previous test flights.

Do not fly any model plane higher than 400 feet (130 meters) anywhere within 3 miles (5 km.) of an airport without notifying the airport operator. Always yield the right-of-way to full-scale aircraft and avoid flying near them.

Always abide by the safety rules of your particular flying field, and never willfully or deliberately fly your models in a careless, reckless or dangerous manner.

FREE-FLIGHT PRECAUTIONS

Never launch model aircraft unless you are at least 100 feet (35 meters) down-wind of spectators and parking areas.

Always clear the launch area except for your mechanic and the officials.

LINE-CONTROL PRECAUTIONS

Subject the complete line-control system to an inspection and pull-test prior to launch.

Double check that your flying area is clear of utility wires and telephone poles.

Clear the flight area of all non-essential spectators and participants before starting your engine.

RADIO-CONTROL PRECAUTIONS

Check your radio equipment on the ground at long range before the first flight of a new or repaired model.

Do not fly your plane in the presence of spectators until you are a qualified pilot, unless you are assisted by an experienced helper.

Always make the initial turn after take-off away from the pit, spectators, and parking areas, and do not perform any flight manoeuvres or landing approach over these areas.

Although good basic guidance, these rules obviously do not cover every situation that may come up on the ground or in the air. You as a pilot, with your skill and common sense, are the final factor in flying safety. Your responsibility is to yourself, your fellow pilots, and the model flying hobby.

Glossary

Aerobatics
Manoeuvres purposely performed that are different from those required for normal flying.
Aerodyne
General expression for all heavier than air airplanes.
Aerostat
General expression for all lighter than air airplanes.
Ailerons
Control surfaces normally located near the trailing edge of the wings.
Air-brakes
Surfaces used to increase drag and/or reduce lift in order to increase the rate of descent.
Airfoil
Any surface designed to produce lift.
Airframe
Framework of the model, the total built-up structure.
Amphibian
Model which can take off and land from either water or land.
Angle of attack
The angle between the plane of the wing and the direction of the airflow.
Aspect ratio
The proportion between average wing chord and the wing-span.
Biplane
Airplane with two main wings, set one above the other.
Cabin
The enclosed portion of an airplane.
Canard
Airplane that flies "tail-first."
Cap strip
Light, flat strip of wood cemented to the top and bottom of wing ribs to provide better support for the covering.

Center of gravity
Point at which an airplane can balance in all directions.
Center of pressure
Point at which lift and drag acts on a wing section.
Chord
Distance between leading edge and trailing edge of a wing.
Cockpit
The forward portion of the cabin, where the instruments are located.
Control surface
Movable surface used in order to change the flight path.
Cowling
Fairing around the engine.
Cross section
Sectional view at a specified point of the model.
Datum line
Reference line for a model design to which all angles are related.
Dihedral
The angle at which the wings are inclined upwards from the horizontal.
Drag
Forces acting in a backward, restraining direction on the model during flight.
Duration model
Model designed and built in order to obtain maximum duration of the flight.
Elevator
Horizontal tail control surfaces used to make the model climb and descend.
Fin
Vertical surface at the tail to which the rudder is usually attached. Aids directional stability.
Flaps
Movable rear portion of the wings used to increase lift at low speeds, reducing the length of the landing run.
Flat spin
A spin in which the longitudinal axis of the model is nearer the horizontal than the vertical.

Flutter

Rapid oscillation of a control surface or wing.

Formers

Shaped parts which act as supports for stringers and covering on the fuselage.

Incidence

See "Angle of attack."

Jig

Apparatus used to hold parts in correct alignment during assembly.

Lateral stability

The ability of a model to return to normal flight from a forced bank.

Leading edge

Forward edge of a wing, fin, tailplane or propeller.

Lift

Upward force acting on the model during flight.

Longitudinal stability

The ability of a model to return to normal flight from a forced dive or climb.

Monoplane

Airplane with one wing.

Parasol wing

Airplane with the wing mounted on struts above the fuselage.

Pitch

The theoretical distance a propeller would travel in a forward direction during one complete revolution.

Power loading

Total weight of the model divided by the engine power.

Pressure tank

Special tank which feeds fuel to the engine using pressure.

Pusher

A model with the propellers mounted in the rear of the wing.

Rib

A former which gives the external shape for the covering on the wing, tail and fin.

Rudder

Vertically mounted control surface at the tail used to control the model directionally.

Slot

Device fitted to the leading edge of a wing in order to maintain lift at speeds below normal stalling speed.

Span

Overall distance from tip to tip of the wing.

Spinner

Streamlined fairing over the propeller hub.

Stall

The situation where a wing is above the angle of attack corresponding to maximum lift coefficient.

Thermal

Warm air masses rising vertically from the ground.

Thrust

Power produced by the propeller.

Thrust-line

Line through the propeller axis.

Torque

Force created by a revolving propeller that tends to turn an aircraft in the direction opposite to the propeller's rotation.

Tow hook

Hook on the underside of a glider fuselage.

Trailing edge

Rear edge of a wing.

Undercamber

Concave underside of a wing-section.

Wash-in

Wing design which increases the angle of incidence towards the wing tips.

Wash-out

Wing design which decreases the angle of incidence towards the wing tips.

Wing loading

Total weight of the model divided by the area of the supporting surface of the wing.

Yaw

The movement of the model around a vertical axis through the center of gravity.

Zoom

Rapid height gain when pulling up from a dive.

Index

MODEL FLYING HANDBOOK

Pilot your own plane?
Challenge wind and sky?

You can—with the information in this book—experience all the thrills of full-scale flight without any of its dangers. With it you can learn how to build your own scale-model aircraft and fly them through basic patterns and daring ones!

The author, a Norwegian Air Force pilot and a champion model builder and flyer, starts you off by explaining the principles of aerodynamics so that you understand how your plane flies. Then he introduces you to every type of model plane, from simple free-flight gliders that a youngster can make to more challenging rubber-powered models, line-controlled craft, and radio-controlled power
sailplanes. Whatever type of plane you want to fly, h
choose your first model, gives tips on building and trim
helps you launch it on its first successful flights.

You'll also find a wealth of information on
- engines
- propellers
- radio-control equipment
- tools and building materials
- transporting your model
- flying safety
- flying terms (in the glossary)

If you're just beginning—or if you're an enthusiast a
is the book to fly with!

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